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ABSTRACT

The Comprehensive School Mathematics Program (CSMP) is a program of CEMREL, Inc., one of the national educational laboratories, and was funded by the National Institute of Education (NIE). Its major purpose is the development of curriculum materials for the elementary grades. Beginning in September 1973, CSMP ran an extended pilot trial of its elementary program. The material looks at the results of interviews carried out in the St. Louis area with nine CSMP and nine non-CSMP fourth-grade classes. Six students were selected from each class. The nine CSMP classes were veteran classes having used CSMP as their regular program since first grade. Six different problem exercises were administered to subjects. Results showed significantly higher scores for CSMP pupils than non-CSMP individuals on two of the exercises, some difference thought worth noting on one additional problem also favoring CSMP students, and small and not significant differences between groups on the other three measures. It is noted that boys in both CSMP and non-CSMP groups outperformed their female classmates. (MP)

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**EXTENDED PILOT TRIALS OF THE
COMPREHENSIVE SCHOOL MATHEMATICS PROGRAM:**

EVALUATION REPORT SERIES

**Evaluation Report 5-B-2
Individually Administered Problems
Fourth Grade**

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Extended Pilot Trial of the
Comprehensive School Mathematics Program

Evaluation Report 5-B-2
Individually Administered Problems

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Martin Herbert
November, 1978

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Description of Evaluation Report Series

The Comprehensive School Mathematics Program (CSMP) is a program of CEMREL, Inc., one of the national educational laboratories, and is funded by the National Institute of Education. Its major purpose is the development of curriculum materials for grades K-6.

Beginning in September, 1973, CSMP began an extended pilot trial of its Elementary Program. The pilot trial is longitudinal in nature; students who began using CSMP materials in kindergarten or first grade in 1973-74, were able to use them in first and second grades respectively in 1974-75, and so on in subsequent years. Hence the adjective "extended".

The evaluation of the program in this extended pilot trial is intended to be reasonably comprehensive and to supply information desired by a wide variety of audiences. For that reason the reports in this series are reasonably non-technical and do not attempt to widely explore some of the related research issues. The list of reports from the first two years of the extended pilot trial is given on the next page. The most comprehensive of these are the following:

- 1-A-1: Overview, Design and Instrumentation
- 1-A-3: Final Summary Report, Year 1
- 2-A-1: Final Summary Report, Year 2
- 3-B-1: Summary of Second and Third Grade Test Data Year 3
- 4-A-1: Final Summary Report, Year 4
- and 5-A-1: Summary Data Through Year 5

Longitudinal Pilot Study of the Comprehensive School Mathematics Program

Evaluation Report Series

Evaluation Report 1-A-1	Overview, Design and Instrumentation
Evaluation Report 1-A-2	External Review of CSMP Materials
Evaluation Report 1-A-3	Final Summary Report Year 1
Evaluation Report 1-B-1	Mid-Year Test Data: CSMP First Grade Content
Evaluation Report 1-B-2	End-of-Year Test Data: CSMP First Grade Content
Evaluation Report 1-B-3	End-of-Year Test Data: Standard First Grade Content
Evaluation Report 1-B-4	End-of-Year Test Data: CSMP Kindergarten Content
Evaluation Report 1-B-5	Test Data on Some General Cognitive Skills Related to CSMP Content
Evaluation Report 1-B-6	Summary Test Data: Detroit Schools
Evaluation Report 1-C-1	Teacher Training Report
Evaluation Report 1-C-2	Observations of CSMP First Grade Classes
Evaluation Report 1-C-3	Mid-Year Data from Teacher Questionnaires
Evaluation Report 1-C-4	End-of-Year Data from Teacher Questionnaires
Evaluation Report 1-C-5	Interviews with CSMP Kindergarten Teachers
Evaluation Report 1-C-6	Analysis of Teacher Logs
Evaluation Report 2-A-1	Final Summary Report Year 2
Evaluation Report 2-B-1	Second Grade Test Data
Evaluation Report 2-B-2	Readministration of First Grade Test Items
Evaluation Report 2-B-3	Student Interviews
Evaluation Report 2-C-1	Teacher Questionnaire Data
Evaluation Report 2-C-2	Teacher Interviews, Second Grade
Evaluation Report 2-C-3	Teacher Interviews, First Grade
Evaluation Report 3-B-1	Second and Third Grade Test Data Year 3
Evaluation Report 3-C-1	Teacher Questionnaire Data Year 3
Evaluation Report 4-A-1	Final Summary Report Year 4
Evaluation Report 4-B-1	Standardized Test Data, Third Grade
Evaluation Report 4-B-2	Mathematics Applied to Novel Situations (MANS) Test Data
Evaluation Report 4-B-3	Individually Administered Problems, Third Grade
Evaluation Report 4-C-1	Teacher Questionnaire Data, Third Grade
Evaluation Report 5-A-1	Summary Data Through Year 5
Evaluation Report 5-B-1	Fourth Grade MANS Test Data
Evaluation Report 5-B-2	Individually Administered Problems, Fourth Grade
Evaluation Report 5-C-1	Teacher Questionnaire and Interview Data, Fourth Grade

Key to Indexing

Evaluation Reports are labelled m-X-n,

where m is the year of the pilot study, with 1973-74 as Year 1.
X is the type of data being reported where A is for overviews
and summaries, B is for student outcomes and C is for other data.
n is the number within a given year and type of data.

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Introduction

The Comprehensive School Mathematics Program (CSMP) is a curriculum development project of CEMREL, Inc., a regional educational laboratory located in St. Louis, Missouri. As curriculum materials are developed, on a year-by-year basis, they are used by a few teachers in a local setting in what is called a "local pilot test". Upon revision, the materials are then used in many school systems and the effectiveness of these materials is evaluated during what is called an "Extended Pilot Test".

The Extended Pilot Test began in 1973 with kindergarten and first grade materials. By 1977 materials through fourth grade had been developed and the 1977-78 school year constituted the first of two years of the External Pilot Test (EPT) for fourth grade materials with 36 fourth grade CSMP classes located in 16 school districts.

Because the St. Louis area provided the largest concentration of such classes and because new assessment measures were being developed, that part of the evaluation dealing with the assessment of student outcomes was restricted to the St. Louis area ("local" to CEMREL). This assessment will be broadened to other areas during the second EPT year. Three kinds of tests were used: standardized tests (given routinely by the school districts), the MANS Scales (Mathematics Applied to Novel Situations, see Evaluation Report 5-B-1), and the individually administered problems of this report. Always, CSMP students are compared with Non-CSMP students on these tests.

The present report covers the individually administered problems which are designed for three purposes. (1) It enables the asking of questions which can not realistically be posed in a group, paper and pencil setting. (2) It enables the recording of students' methods as well as their products. (3) It provides a means of confirming or disconfirming the results from the group testing.

Setting and Design

The problems were developed by the evaluation staff with the guidance of the program writers and an evaluation panel of outside experts in the field. The experience of previous years' individual testing was taken into account by incorporating some aspects of previous problems into this year's exercises, particularly: mental arithmetic, the use of an efficient elimination strategy in guessing a number, and the use of multiplication instead of repeated addition. Other exercises were born of frustration with trying to measure the same abilities in the group, paper-and-pencil setting, particularly with "problems and hints", and with estimation tasks.

In all, eleven exercises were devised and pilot tested with students of varying abilities from three classes just beginning CSMP study at the fourth grade. Six of the exercises survived the pilot testing; i.e., they were easily administered, appeared to be measuring the intended ability, were within the capability of the range of student abilities, and seemed to be fun for the students. Below is a brief description of the six exercises, each of which will be described in more detail in the next section of the report.

Mental Arithmetic - eight problems susceptible to easy mental calculation by a method other than the standard algorithm, presented orally and in writing, and to be done out loud without benefit of paper and pencil.

Problems and Hints - four problems not susceptible to easy mental calculation presented in writing; along with each problem were three similar problems to be considered as hints.

Subtraction Estimation - eight subtraction problems, not susceptible to exact calculation mentally, to be quickly considered for an approximate answer.

Zero to Ninty-nine - a "twenty-questions" type of exercise involving the numbers 0 to 99.

Guess My 24 - the "reverse" of the previous exercise in which the student answered a series of interviewer questions about the number 24.

Blocks of Squares - seven different sets of squares contained in varying shaped blocks to be "counted" using the most efficient system possible.

The interviews were carried out in the local St. Louis area as part of the larger testing program. A total of 9 CSMP and 9 Non-CSMP fourth grade classes from three school districts participated in this study. These nine CSMP classes (though not every student) were "veteran" classes in the sense that they had used CSMP as their regular math program since first grade. Schools and classes were paired, CSMP with Non-CSMP, so that within pairs, classes were of about equal ability and schools were located in fairly similar neighborhoods.

From each of the 18 classes, six students were selected. Each class was subdivided into three similar-sized groups of High, Average and Low scoring students based on their scores on the Kuhlmann Anderson Test, a test of general ability which was administered to all classes earlier in the year. Then one boy and one girl were selected from about the middle of each of these 3 groups. In this way it was hoped that the 6 students selected would, as a group reflect fairly well the ability level of the class as a whole. Table 1 shows, for each of the 18 classes, the mean score for the selected students versus the mean score for the class as a whole.

Table 1
Class Means; Kuhlmann Anderson Scores

	CSMP Classes		non-CSMP Classes	
	Mean of Entire Class	Mean of Chosen Students	Mean of Entire Class	Mean of Chosen Students
FORM A	66.7	66.3	58.5	58.8
	68.4	69.7	72.9	71.7
	83.7	83.3	75.3	81.8*
	87.6	88.7	83.5	83.8
	92.9	90.8	85.7	83.8
FORM B	66.2	69.5	53.1	57.5*
	78.3	76.5	80.3	82.2
	85.3	85.0	82.9	84.3
	89.6	90.5	89.6	90.5
GRAND MEAN	79.9	80.0	75.8	77.2

It can be seen that the means are quite close except for the two non-CSMP classes (marked with an asterisk) where the chosen students were quite a bit better than the rest of the class.

All classes were administered Mental Arithmetic, Problems and Hints, and Subtraction Estimation. The 5 pairs of classes listed for Form A were also administered Zero to Ninety-nine and Guess My 24, and the 4 classes listed for Form B were also administered Blocks of Squares.

The students were interviewed individually in a relatively secluded spot in the school by one of four interviewers. The interviews lasted 30 to 45 minutes and were tape recorded. The interviewer recorded the results for scoring from that tape. The four interviewers worked with 1, 1, 3, and 4 pairs of classes respectively.

With the exception of the mental arithmetic exercise for some students, the interview was a reportedly enjoyable experience. In fact, all but the least capable students generally reported that they enjoyed the entire interview. In order to avoid undue frustration on the part of the least capable students, the mental arithmetic and blocks or squares routines were truncated at places where no further progress could be expected. Most of the students were a bit disappointed when the interview was over and many had difficulty at the end rank ordering the exercises, since they had "liked them all".

Scale by Scale Results

In this chapter each scale is described together with a summary of the resulting data. Data will be presented in two forms: 1) number or percent of the students in each group who responded in various ways to a given item and 2) analysis of class means, in which the class is used as the unit of analysis in an Analysis of Covariance procedure (in which scores are adjusted to reflect differences in ability level as measured by Kuhlmann Anderson scores). Sometimes the Kuhlmann Anderson is referred to as the "covariate".

Mental Arithmetic

For the mental arithmetic exercise the student was shown some problems (one at a time on cards) which would be "easy to do with paper and pencil, but I want you to do them in your head, perhaps using some short cuts." The student was reassured that the interviewer was not as interested in a correct answer as in the method used. The student was encouraged (prodded if need be) to verbalize the method being used and was reminded that short cuts were allowable. An easy item ($301 + 303 + 302$) was used as a warm-up and every effort was made to make the student feel as comfortable as possible. After a student arrived at an answer, the interviewer usually asked if the student thought it reasonable. (If the answer was, in fact, unreasonable the question was always asked, otherwise it was sometimes asked in order to avoid giving the impression that the reasonableness question was really a euphemism for "you're wrong!") Help was given to the student whenever necessary but a record was kept of whether it was "non-crucial" (for example, reminding the student of an intermediate result) or "crucial" (without which the student would be unable to make progress in solving the problem).

The record of the items in this exercise were scored on the following dimensions:

- I. Correctness of Result Obtained
 - A. Correct Answer
 - B. Incorrect but reasonably close answer
 - C. Unreasonable answer or needed crucial help in order to make progress.

II. Method Used to Solve the Problem

- A. Used a standard algorithm
- B. Used an alternative method (for example, changing the problem to a similar one which could be calculated easily and then readjusting the answer.)
- C. Couldn't do the problem without lots of help

III. Student response to whether or not he thought his answer was reasonable.

In Table 2 the results from I. and II are given for each of the seven items of this exercise.

Table 2
Percent Correct and Percent Using Various Methods,
Mental Arithmetic Items

(First Number for CSMP Students, Second Number for Non-CSMP Students)

Problem Shown To Student	Correctness of Answer ¹			Percent Using Various Methods ¹			Percent Correct by Method Used ²	
	Percent of Students Whose Answer Was:			Standard Algorithm	Alternative Method	No Progress	For Those Using Standard Algorithm	For Those Using Alternative Method
	Correct	Reasonable	Unreasonable					
Add 542 and 99	65 65	15 06	20 30	83 85	13 11	04 04	62 63	100 100
Subtract 99 from 201	55 39	13 15	31 46	59 53	28 33	13 14	56 31	80 67
Subtract 244 from 543	39 35	31 33	30 31	70 74	20 09	10 17	37 40	64 60
Multiply 99 by 8	53 46	13 13	33 41	63 72	17 07	20 21	71 62	56 25
Multiply 500 by 12	35 32	07 06	57 72	37 54	55 22	28 24	30 28	68 33
Divide 150 by 25	61 43	04 07	35 50	04 02	69 52	27 46	100 0	84 82
Divide 1000 by 4	46 17	04 04	50 80	17 15	48 22	45 63	67 73	73 42
Mean	51 38	12 12	37 50	48 51	33 22	21 27	54 47	76 64

¹Based on 54 students each

²Based on varying number of students depending on how many used the particular method. Hence the means in the last row were calculated by summing across items to get "total number correct" $\div$ "total number attempted" for each method.

From Table 2 it can be seen that:

- i) CSMP students got more calculations correct and gave fewer unreasonable answers than did Non-CSMP students, and this advantage was greatest for the two division items.
- ii) Use of an alternative method tended to produce better results than use of the standard algorithm, for both CSMP and Non-CSMP students (but also tended to be used more often by the higher ability students).
- iii) CSMP students were more likely to use an alternative method than were Non-CSMP students, particularly on the multiplication and division items. This factor alone did not account for their overall superiority in correctness of answer however; higher percentages correct were attained by CSMP students for both "standard algorithm" and "alternative method".

The above analysis used averages across students. An alternative method of analysis was used in order to investigate statistical significance. A mean score for each class was calculated and an Analysis of Covariance procedure was used on the set of class means. This method allows one to "take into account" differences in class ability, as measured by Kuhlmann Anderson Test Scores. Figures 1 and 2, next page, show the graphs of these class means for number correct and number of times an alternative method was used. Also given within the figures are Tables 3 and 4 showing mean scores across classes before and after adjustment for the Kuhlmann Anderson, and p-value - the probability of such differences occurring by chance alone.

Number Correct,
Mental Arithmetic

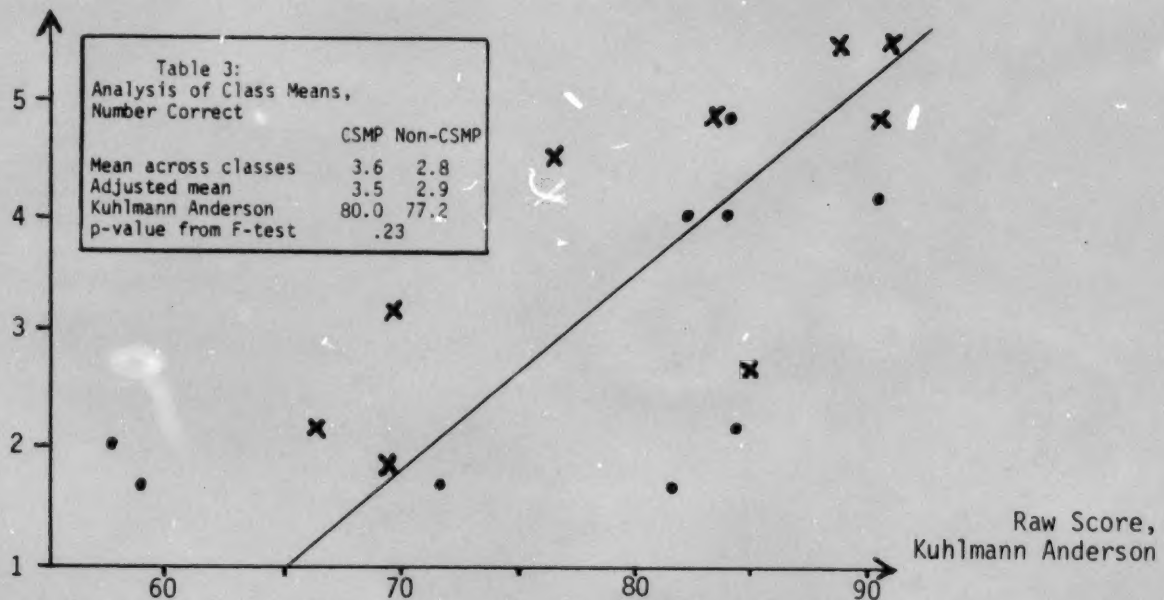


Figure 1 Class Means: Number Correct, Mental Arithmetic
(x = CSMP Class, • = Non-CSMP Class)

Use of Alternative Method,
Mental Arithmetic

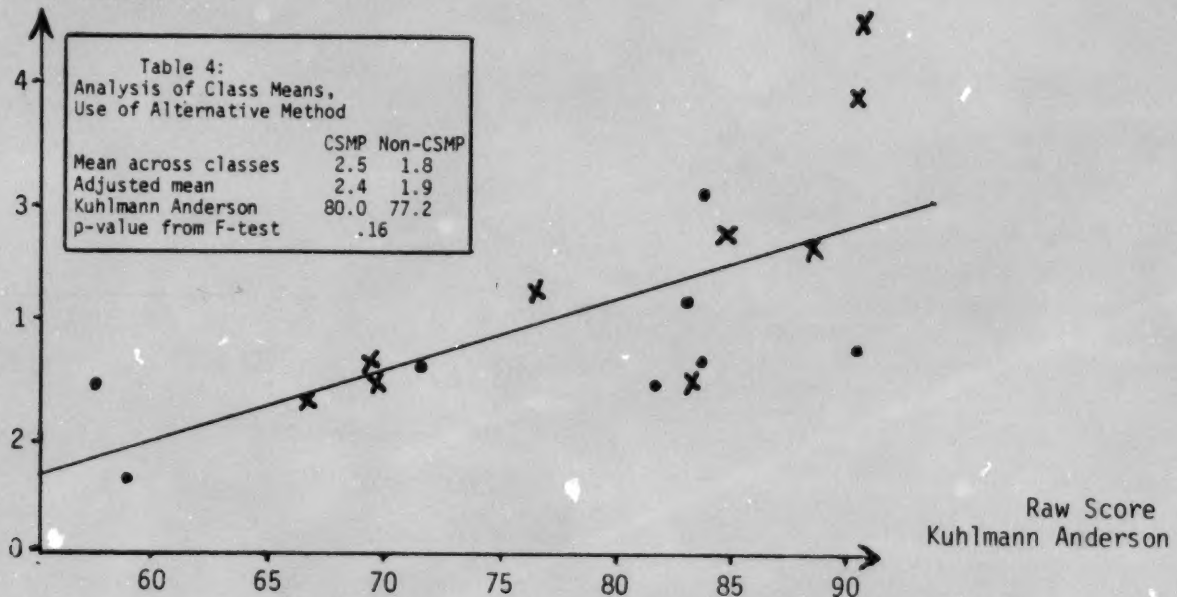


Figure 2 Class Means: Number of Uses of Alternative Methods,
Mental Arithmetic
(x = CSMP Class, • = Non-CSMP Class)

It can be seen from the tables in the above figures that in neither case did the p-value reach .05, the value usually thought of as significant. This is somewhat surprising in view of what seem to be substantial and consistent differences in favor of CSMP students (between $1/3$ and $1/4$ of a standard deviation in each case). It should be pointed out that this method of analysis is a rather conservative one in this instance, particularly with sampling within classes, and that the data do not fit the regression model particularly well (and nowhere near as well as group administered tests typically do). More light will be shed on this issue later when scores by student ability level are investigated.

The interviewer asked if the student's answer seemed reasonable, especially if the answer was in fact unreasonable. A correct response in this instance would be, "No". The relevant situation arose 153 times, somewhat more often for Non-CSMP students and/or for students using a standard algorithm since these two groups arrived more often at unreasonable answers. The correct response ("No") was given in almost exactly one quarter of the cases regardless of curriculum and regardless of method used.

Problems and Hints

This exercise involved problems with arithmetic calculations too difficult for a fourth grader to do quickly without pencil and paper.

With each problem the routine was the same. The student was shown the problem on a 4 X 5 card and told not to work it because a hint would be given.

This hint consisted of a similar calculation and was also presented on a 4 X 5 card.

(For example, Problem: $277 + 277$ Hint: $277 + 177$)

The student was asked if the answer to the hint would be helpful in obtaining the answer to the problem. If the student answered that it would, the interviewer asked for an explanation of how it would be helpful. Two more hints were presented, one at a time, using the same procedure. The student was then asked which of the three hints would be most helpful.

For each hint the student's response was classified as either a) saw it as helpful and had an explanation which would have led to a correct answer to the problem, b) saw it as helpful but did not have a good explanation or c) saw it as not helpful.

A few students had difficulty understanding the task and the interviewer noted this when it happened and whether or not this difficulty persisted throughout the exercise. Altogether, 9 CSMP students and 14 non-CSMP students (about 20% in all) had difficulty and the difficulty persisted for 3 and 6 students respectively.

Four problems were done in this way, each followed by 3 different hints. There was one problem each in addition, subtraction, multiplication and division.

In the following figure each of the problems will be presented in turn. Below each problem are given the three hints (A, B, C) that were used with that problem. Then below each hint two numbers are given; they are the number of CSMP and non-CSMP students respectively who got the item correct (out of 54 possible in each case).

Figure 3 Problems & Hints
Number of CSMP, then Non-CSMP students able to use the hint (out of 54).

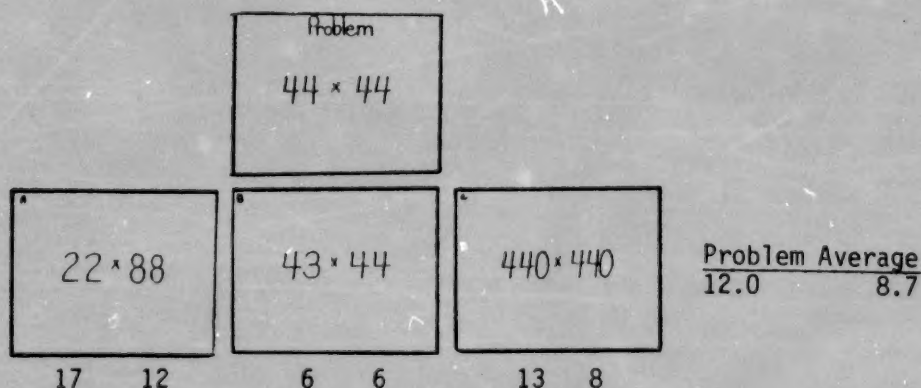
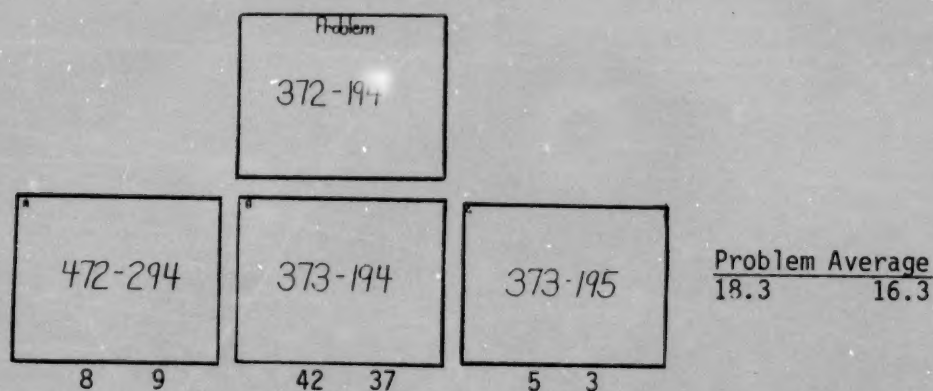
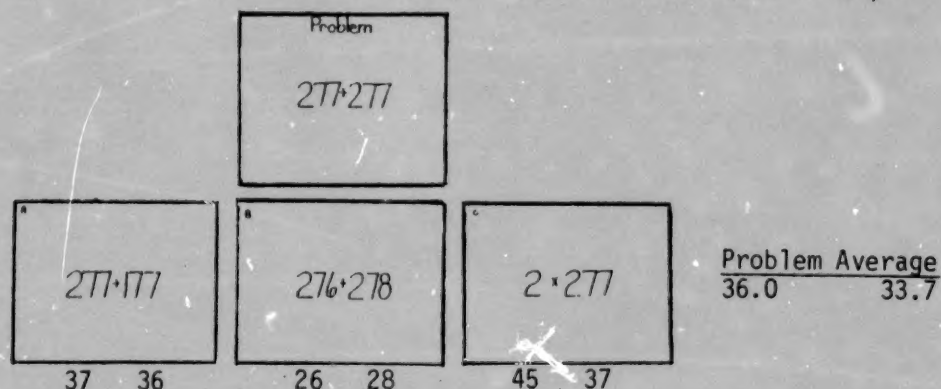
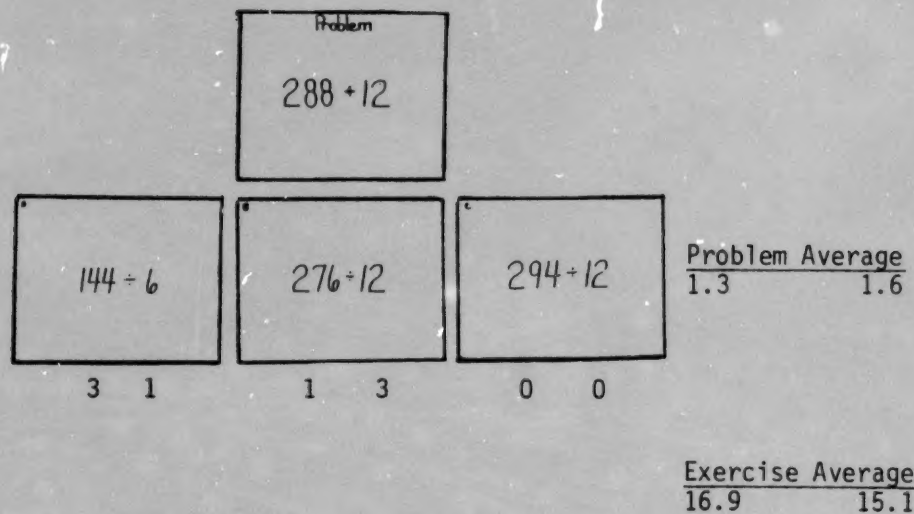


Figure 3 (con't)



There was very little difference between CSMP and Non-CSMP students, and this is confirmed in the analysis of class means in Table 5, below, in which the differences were not significant. The problems got progressively harder - the mean percent correct being 65, 32, 19 and 3(!) for the addition, subtraction, multiplication and division problems respectively.

Table 5
Problems & Hints
Analysis of Covariance on Class Means

Number of hints successfully used:

	CSMP	Non-CSMP
Mean Raw Score	3.8	3.3
Mean Adjusted Score	3.6	3.4
Mean Score, Kuhlmann Anderson	80.0	77.2
P - value on analysis of	.71	

Subtraction Estimation

This exercise consisted of eight problems like the following example:

$260 - 211$

0 10 50 100 500 1000

with the task being to simply mark an "x" between the two numbers where the answer would lie.

In the instructions, it was stressed that it was not proper to calculate an exact answer, but to "look at the (calculation) and decide quickly where the 'x' would go."

For practice, the student was given a sheet with two items on it. The first already had the "x" marked correctly, emphasizing that an exact answer was unnecessary. The second item, $150 - 69$, was done by the interviewer and student together, with the interviewer giving some clues as to how one might figure out that the answer would be greater than 50 and less than 100.

When the interviewer was satisfied that the student understood the task, the student received a second sheet with 8 subtraction items of a similar nature and was told to do them as quickly as possible. There was no time limit, but the student was told he was being timed (the average time required for the 8 items was about $1\frac{1}{2}$ minutes).

For each item, the student's response could be classified as "correct", "reasonable" (correct or next best answer), or "unreasonable" (any other

response). For example, with the first item, "100 - 93", the interval 0 - 10 was correct, the interval 10 - 50 was also reasonable and all the other intervals were classified as unreasonable.

In addition every response that was not correct was classified either as an underestimate (an interval to the left of the correct answer) or as an overestimate (an interval to the right). Thus each student could be given a score on this scale for: number correct, number reasonable, number unreasonable, number underestimated and number overestimated as well as the time in seconds required to complete the items.

The item by item results are given in the following table with CSMP figures to the left and non-CSMP to the right.

Table 6
Subtraction Estimation
Percent of Responses (out of 54 students) for CSMP, then Non-CSMP students

	Correct	Reasonable	Unreasonable	Overest.	Underest.
100 - 93	48 43	74 67	26 33	52 57	impossible
149 - 51	78 67	81 78	17 22	9 11	11 22
137 - 125	44 41	67 54	33 46	33 46	22 13
970 - 459	39 44	89 81	11 19	impossible	33 54
260 - 211	43 31	78 65	22 35	57 69	0 0
671 - 662	33 20	61 48	37 50	65 76	impossible
700 - 205	59 59	89 83	11 17	30 24	11 17
651 - 149	44 30	94 85	4 15	impossible	54 70
Mean	49 42	80 70	20 30	31 35	20 22

From the raw data one can see that the CSMP students were a bit more accurate and a bit less unreasonable in their responses, but had no real superiority on any particular item. Neither group predominated in terms of over or under estimating, given the difference in number of correct responses.

Using class means across CSMP classes and across non-CSMP classes, an analysis of covariance produced the following data.

Table 7
Subtraction Estimation
Analysis of Covariance on Class Means

Number correct	<u>CSMP</u>	<u>non-CSMP</u>
Raw score mean	3.9	3.3
Adjusted means	3.8	3.5
Covariate	80.0	77.2
p-value or analysis of covariance	.42	

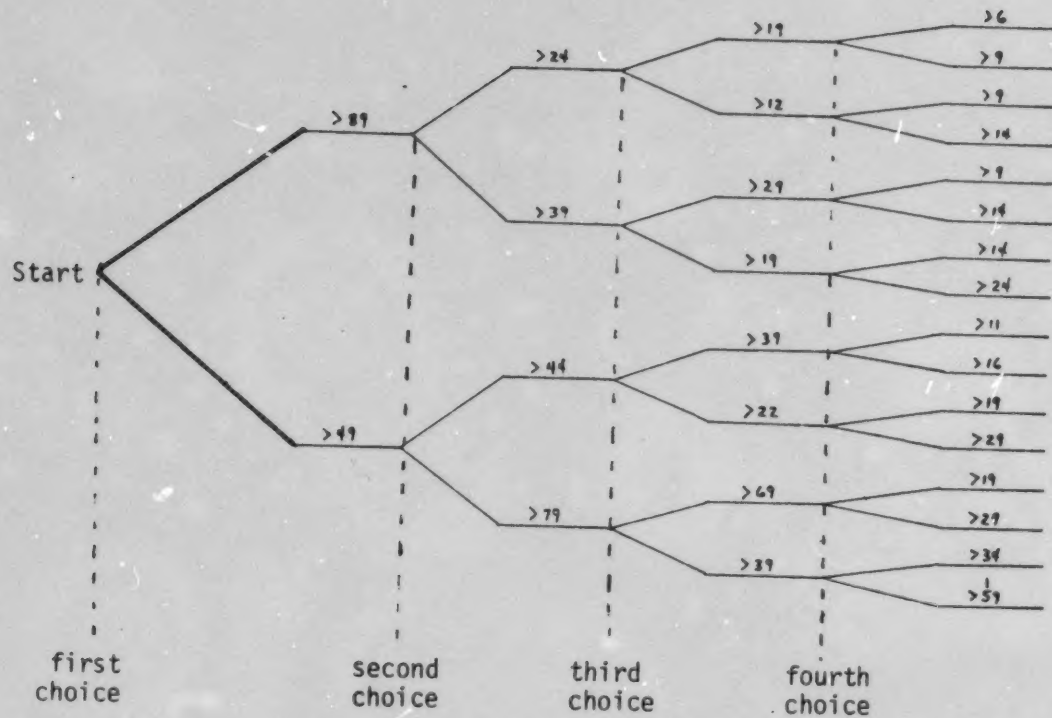
While the adjusted means show an advantage to CSMP, the result is not significant. A similar set of data and conclusions could be presented for number of reasonable responses per student, the advantage to CSMP students being slightly greater, (p-value = .18). It should be pointed out that there was a difference in the average amount of time spent on this exercise: 96.2 seconds for CSMP and 80.1 seconds for non-CSMP.

Zero to Ninety-nine

This exercise was in Form A only and was administered in 5 pairs of classes. In the exercise the student was handed an $8\frac{1}{2} \times 11$ sheet of paper with the whole numbers 0 to 99 written on it in a ten-by-ten array. The student was told that the interviewer was thinking of one of those numbers which the student should try to figure out by asking questions. In fact the student was to choose one of two given questions to ask. At this point the student was asked " ' Is it greater than 89?' or 'Is it greater than 49?', 'Which do you want to ask?' (The questions seem complicated as written here, but the students had no difficulty understanding the task and made their choices rapidly.) The student was then asked why that choice was made. Regardless of the choice, the student was told "No, my number is not _____. " After a pause, the student was asked to say which numbers had thereby been eliminated. Once this had been done correctly (with help if necessary), the student was given the opportunity to cross them out (on the array) with a colored marking pencil.

The above routine was repeated three more times using the question schedule shown in Figure 4. (In effect, the student moves from left to right in this path, making 4 choices along the way.)

Figure 4 Zero to Ninety-nine
Question Schedule



(Because each question is answered by the interviewer with "No, it's not greater than ____", the student is always left with the numbers zero to n depending on how many have been eliminated.)

After the fourth choice, the student was given the opportunity to ask new questions. The interviewer answered "Yes" or "No" depending on which would leave the most numbers uneliminated.

The choices in this exercise were scored primarily from the point of view of whether or not the student used the most efficient elimination strategy (e.e.s.) and could verbalize an understanding of it. This included picking that question in each of the first four choices which eliminated about half the remaining numbers (as opposed to the other question which would eliminate only a small proportion), being able to say why those choices were better, continuing with this strategy when left to his/her own devices, and abandoning the strategy when only 2 or 3 numbers were left.

Also recorded was how well the student could work with the concept "not greater than". (When told that the secret number was not greater than n, did the student eliminate the numbers greater or less than n? Did the student eliminate n itself?)

Using class means across CSMP classes and across non-CSMP classes, the following data can be presented.

Table 8
Use & Understanding of an Efficient Elimination Strategy (e.e.s.)
Zero to Nine-nine
Analysis of Covariance on Class Means

	<u>CSMP</u>	<u>non-CSMP</u>
Mean number of e.e.s. responses	2.83	2.73
Mean number of verbalizations of an understanding of the e.e.s.	1.43	1.43
Mean continuation of the e.e.s.	0.36	0.33
Mean abandonment of the e.e.s. when appropriate	0.33	0.56
Total of above	4.96	5.06
Total of above adjusted for covariate	4.90	5.10
Covariate	79.8	76.0
p-value of the analysis of covariance	.41	

Although the non-CSMP students have a somewhat higher score on this scale, the difference is not significant. It should be noted that this difference is largely attributable to the superiority of non-CSMP students in the abandonment of the e.e.s. when appropriate.

As for the matter of working with the concept of "not greater than", CSMP students had an advantage, albeit not significant, in their success with marking out eliminated numbers.

Table 9
Zero to Ninety-nine
Success with Marking Out Eliminated Numbers

	<u>CSMP</u>	<u>Non-CSMP</u>
¹ Mean number correct on "Above or Below n"	3.33	2.86
² Mean number avoided marking out n itself	2.53	2.23

¹For example:

Q: Is it greater than 49?

A: No.

Q: Which numbers should we mark out (i.e. above or below 49)?

A: Above 49.

²In the example above, the numbers above 49 have been eliminated, but not 49 itself. If the student avoided marking out 49 he received credit on the scale.

Guess My 24

This exercise was in Form A only, and was administered in 5 pairs of classes.

In this exercise the student was shown a small translucent plastic container holding many slips of small pieces of paper tightly folded. The student was told that each slip had a number written on it. The student was told to pick one out, look at the number, and not to reveal it to the interviewer. (In fact every slip in the container had '24' written on it).

The student was informed that the interviewer would try to guess the "secret" number by asking a pre-arranged set of questions, some of which were probably going to turn out to be good questions and some not so good. All could be answered by a yes-or-no response and a 'Yes' and a 'No' card were placed in front of the student.

Each question would be accompanied by a card with the key word or phrase from the question. The student should place it under the appropriate yes or no card or to the side to indicate that the question was not a good one.

If the student was not familiar with the concept involved in the question, the interviewer first gave a definition. If the student did not understand the definition, he was given a card listing many members of the defined set.

In any event, the interviewer did not move on to the next question until the student had answered correctly (even if this required considerable correction

and help). The questions are given in Table 10 along with number correct.

After the fourth question the set of possible answers had been reduced to the whole numbers 0-99. The interviewer then brought out a sheet of those numbers (the same as the kind used in Zero to Ninety-nine). From that point one, the interviewer used a marking pencil to indicate which numbers were still possibilities (feigning keeping track for himself but actually doing it for the benefit of the student).

From the fourth question onwards, the interviewer asked whether or not the student thought the question was a good one. If the student thought it was not a good question, the interviewer asked why. In four cases the questions really were stupid (the answer was known from previous questions) or poor (only eliminated a small fraction of the possibilities). Questions 4 and 7 were "stupid"; questions 8 and 11 were "poor".

Table 10
Guess My 24
Percent Correct (Out of 30 Students)

<u>The Questions</u>	<u>With respect to the number 24</u>		<u>With respect to the quality of the question</u>	
	<u>CSMP</u>	<u>non-CSMP</u>	<u>CSMP</u>	<u>non-CSMP</u>
1. Is it a negative number?	93	23		
2. Is it a whole number?	60	27		
3. Is it <100?	97	100		
4. Is it <200?	97	100	73	53
5. Is it odd?	93	70		
6. Is it a multiple of 3?	63	33		
7. Is it a multiple of 6?	67	50	17	17
8. Is it divisible by 5?	57	57	60	50
9. Is it a multiple of 12?	93	70		
10. Is it >50?	100	100		
11. Is it >45?	100	100	97	87

Using class means across CSMP classes and across non-CSMP classes, the following data can be presented regarding yes-or-no responses to the 11 questions.

Table 11
Guess My 24: Eleven Initial Questions
Analysis of Covariance on Class Means

	<u>CSMP</u>	<u>non-CSMP</u>
Mean Number of correct yes-or-no responses about the number 24		
Raw score mean	9.2	7.3
Adjusted score mean	9.0	7.4
Covariate	79.8	76.0
p-value of analysis of covariance	.04	

The superiority of the CSMP students is significant. On an item-by-item basis, this finding can be accounted for by a CSMP superiority on six of the eleven items: the three involving "multiple", and the ones involving "negative", "whole", and "odd". On the other five items the two groups scored equally well.

The analysis of class means regarding the matter of the stupidity or poorness of the four questions that fell under that category were as follows.

Table 12
Guess My 24: Four Follow-up Questions
Analysis of Covariance on Class Means

	<u>CSMP</u>	<u>non-CSMP</u>
Number of correct responses with regard to the quality of the question		
Raw score mean	2.5	2.1
Adjusted score mean	2.4	2.2
Covariate	79.8	76.0
p-value on analysis of covariance	.53	

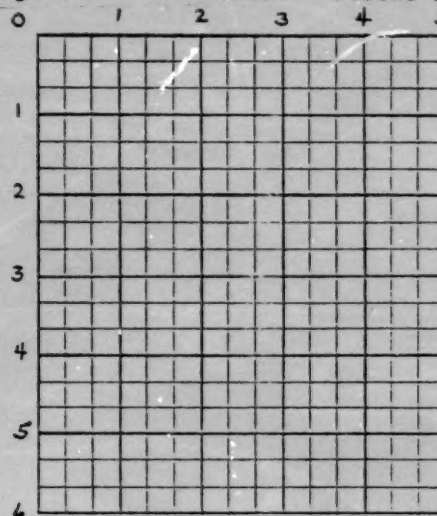
While CSMP students had an advantage over the non-CSMP students, the difference was not significant.

Blocks of Squares

This exercise was in Form B and was administered in 4 pairs of classes.

In this exercise, the student was presented with an 8-1/2 X 11 sheet.

Figure 5 First Sheet: Blocks of Squares

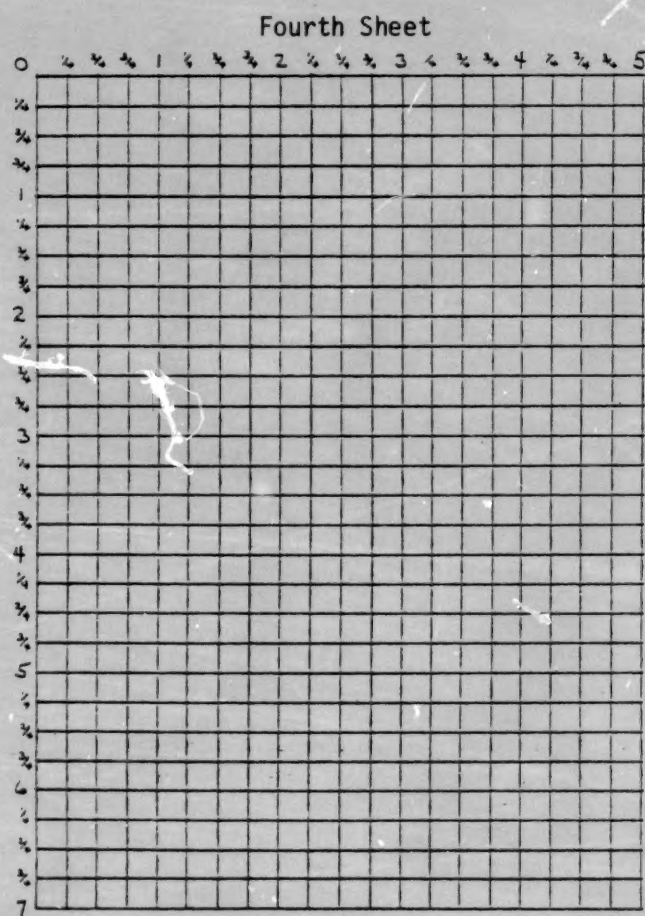
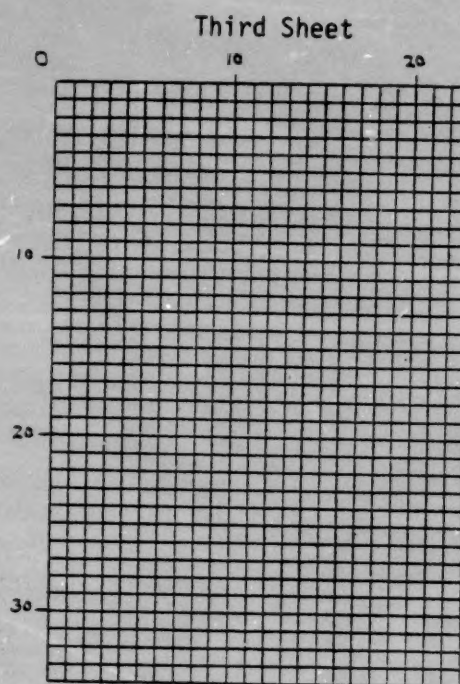
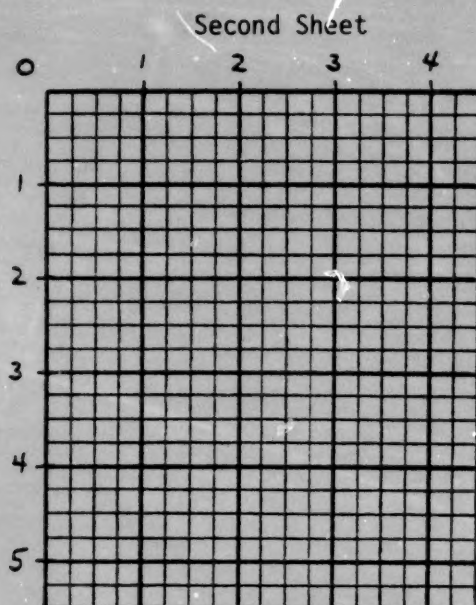


" I want you to tell me how you would figure out how many of these ($\square$) squares are in this whole block of squares." If a student could get nowhere or could only do it by counting by ones, the interviewer acknowledged that it could be done by counting and asked if the student could think of a quicker way.

When a non-counting method was forthcoming, the student was encouraged to clarify it by using a pencil to mark the steps in the process and/or work the resultant calculations in the margins. The student was given any computational help needed.

The following three sheets were done in the same way.

Figure 6 Second, Third and Fourth Sheets: Blocks of Squares



The first 4 blocks of squares were analyzed on four dimensions and the results, combined across the four blocks, are shown in Table 13.

Table 13
Blocks of Squares 1-4
Percent of Students (out of 24)
Giving Various Responses

I <u>Method of Finding Area</u> (Percent of times each method was used)	CSMP	Non-CSMP
a) Area = length x width	60	39
b) Area = $x + x + \dots + x$, where x is the number of squares in a row or column	04	08
c) Area = Ny , where there are N smaller blocks each having area y	24	36
d) Other	00	05
e) No progress beyond counting	11	11
II <u>Percent of Problems Requiring Crucial Help</u>	07	14
III <u>Percent of Problems Eventually Solved</u>	69	55
IV <u>Method of Calculating Length or Width¹</u> (Percent of times each method used)		
a) Multiplies "guide" numbers in margin by number of squares per guide number	37	23
b) Counts by n where n is the number squares per guide number	23	19
c) Counts by ones	40	58

It can be seen that CSMP students were much more likely to calculate the area by length times width, and to calculate length or width by multiplication (and consequently less likely each time to use a one-at-a-time counting process).

¹Based on students who used methods Ia) or Ib)

The last three sheets had somewhat different instructions even though the general task was the same.

Figure 7 Fifth Sheet: Blocks of Squares

"This (point above line) tells us that there are 54 squares in this block. Now pretend we push these 9 blocks together to make a great big block (gesticulate). We want to figure out how many squares would be in that big block. Tell me how you would figure it out."

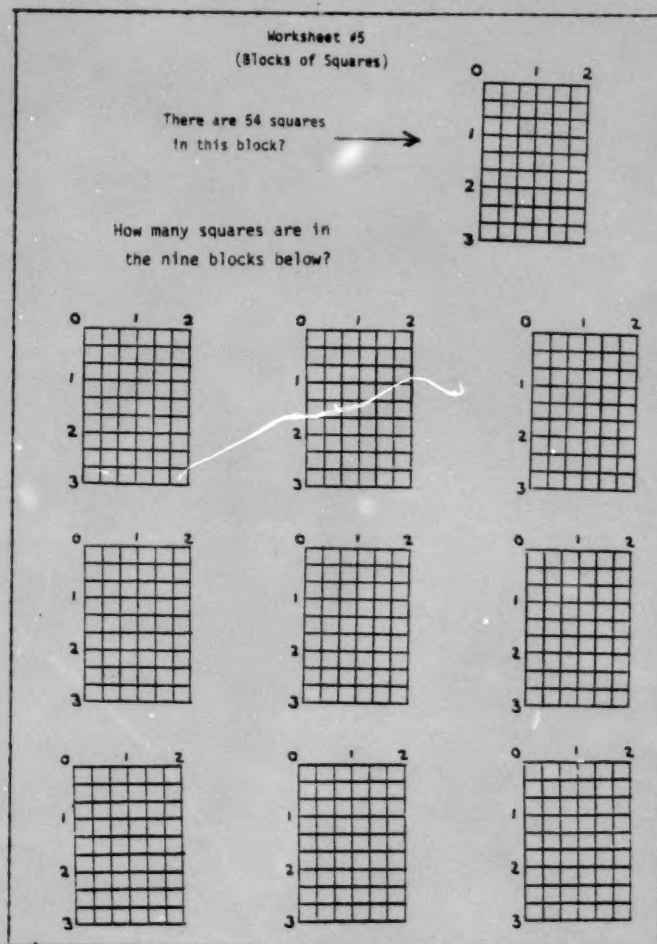


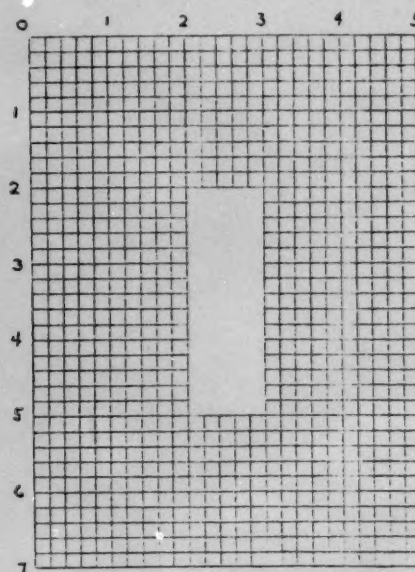
Table 14 shows the percentage of students, out of 24, using various methods of solution.

Table 14
Blocks of Squares
Percent of Students (out of 24)
Various Methods of Solution

Method	CSMP	Non-CSMP
9 x 54	92	50
Reformed the blocks into one big one	0	8
54 + 54 + ... + 54	4	42
Couldn't do the problem	4	0

CSMP students are far more likely to simply multiply 9×54 , as opposed to the repeated addition of 9 54's.

Figure 8 Sixth Sheet: Blocks of Squares



"We want to figure out how many squares are in this block. Remember there aren't any squares here (point to the empty section) so we have to be careful. Tell me how we would figure out how many squares there are."

Here the students were scored on the method of compensating for (or ignoring) the missing squares.

Table 15
Blocks of Squares 6
Percent of Students (out of 24)
Using Various Methods of Solution

	Number of Students	
	CSMP	non-CSMP
Compensates for missing squares		
via addition of parts	38	25
via subtraction	33	21
Unsuccessfully tries to compensate	0	21
Ignores missing squares	8	13
Couldn't do the problem	21	17

More CSMP students were able to compensate for the missing squares, 71% versus 46% (combining the first two categories).

Figure 9 Seventh Sheet: Blocks of Squares

"Here you can see a picture of a table with a strip of squares on it. Tell me how you'd figure out how many squares are on the strip."

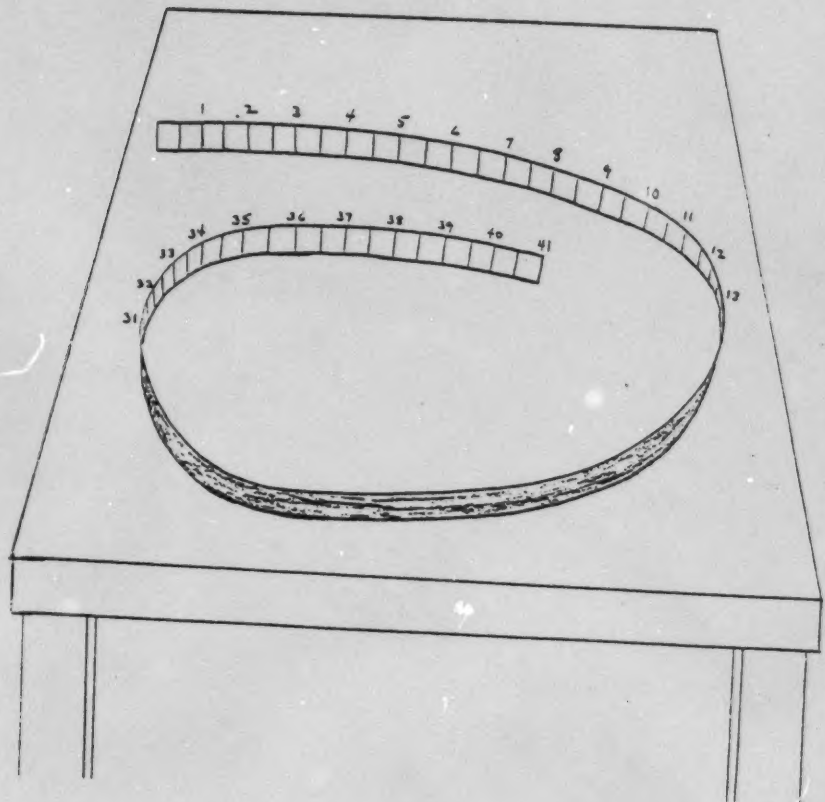


Table 16
Percent of Students (out of 24)
Using Various Methods of Solution

If and how the solution was reached

successful - using 2×41

CSMP

non-CSMP

42

29

unsuccessful - trying to estimate the squares from the back side

21

4

unsuccessful - counting by 2's from the back side

17

29

unsuccessful - using the fact that $31-13=18$

13

8

no progress

8

29

In order to generate class mean scores for the Blocks of Squares exercise, a total score was calculated for each student as follows:

- Number of times length or width calculated, excluding counting (sheets 1-4)
 - + " " " area calculated, excluding counting (sheets 1-4)
 - + Use of 9×54 for calculating area (sheet 5)
 - + Successful compensation of missing square (sheet 6)
 - + Use of 2×41 or $41 + 41$ in finding number of squares (sheet 7)
-
- Total possible = $4 + 4 + 1 + 1 + 1 = 11$

Using class means across CSMP classes and across non-CSMP classes, the following data is presented.

Table 17
Blocks of Squares
Analysis of Covariance on Class Means

	<u>CSMP</u>	<u>non-CSMP</u>
Total score on Blocks of Squares		
Raw score mean	7.4	5.2
Adjusted score mean	7.3	5.3
Covariate	80.4	78.6
p-value on the analysis of covariance	.05	

The CSMP students were superior in this exercise and the difference was significant.

Further Findings

Student Attitude Towards Exercises

At the end of the interview, the students were asked to rank the exercises in order of preference. The average rank for each exercise was almost identical for each curricular group. They were also to mark one of four faces  for the least and most liked exercises. Giving the faces the numbers 1, 2, 3, and 4, the lowest ranked exercise, Mental Arithmetic, was marked on the average 2.9 by CSMP students and 3.1 by Non-CSMP students (i.e., around the third face from the left). The highest ranked exercises, Guess My 24, and Blocks of Squares, were marked 2.1 on the average by CSMP students and 1.9 for Non-CSMP students (i.e., the second face from the left).

To give an idea of the attitude towards the interview as a whole, the following table shows the marking for the highest and lowest ranked exercises (whichever exercises they might have been for each student).

Table 18
Attitude Ranking (Number of Students)

Face Marked	Highest Ranked Exercise		Lowest Ranked Exercise	
	CSMP	Non-CSMP	CSMP	Non-CSMP
1	35	43	1	0
2	17	8	8	3
3	2	3	25	33
4	0	0	20	18
Total	54	54	54	54

There are very small differences between CSMP and Non-CSMP students: Non-CSMP students marked their most liked exercise higher but CSMP students marked their least liked exercise higher. Overall, most students marked their favorites in the left-most (happiest) face and the least favorites in the third from the left (neutral) face or right hand (sad) face. Students seldom marked all faces happy or all faces sad.

Comparisons with Other Data

In the cases where it is possible, it is interesting to compare this year's interview results from Grade 4 with those of last year in Grade 3. Two exercises were similar to individually administered problems in third grade the previous year. The Blocks of Squares exercise was scored for the use of multiplication as opposed to repeated addition and CSMP students scored significantly higher. Last year, in a word problem exercise, CSMP students were more likely to multiply 7×69 and much less likely to add 69 seven times than Non-CSMP students, (see Report 4-B-3, p. 11). Hence CSMP students appear to be more likely than Non-CSMP students to use multiplication when there is a choice between it and repeated addition.

The other similarity occurred with this year's exercise Zero to Ninety-nine, in which the student was scored on fidelity to an efficient elimination strategy, and last year's exercise, Twenty Questions Number Line, in which students were free to invent their own strategy. This year's results were somewhat favorable to Non-CSMP. Last year's "game" was played twice; the advantage CSMP students had in the first game was reduced to zero in the second by virtue of Non-CSMP students improvement both in terms of number of questions asked and sophistication of strategy (p. 12, Report 4-B-3).

Three of the exercises were similar to some of the group-administered MANS Scales. Unless otherwise noted, the MANS scales were administered to these same fourth grade classes.

(1) The Mental Arithmetic exercise has similarities with the MANS Scale, Large Number Computation; indeed the correlations between the scores are in the .7 range. CSMP students outperformed the Non-CSMP students on both the Mental Arithmetic and the Large Number Computation although the difference in the former case was not significant.

(2) A somewhat similar situation occurred in the case of the Problems and Hints exercise and the MANS Scale, Using Hints although the correlations between the two scores was only .4. CSMP students had slightly higher scores both times but neither difference was significant.

(3) The Subtraction Estimation exercise can be compared in two ways. The identical scale was used in MANS/77 with third graders. The table below compares the mean scores (adjusted for differences in covariate) in the two years.

Table 19
Adjusted Means: Estimation Subtraction

	CSMP	Non-CSMP
MANS/77 (3rd Grade)	2.5	2.5
Interviews/78 (4th Grade)	3.8	3.5

The differences are not significant in either year though CSMP students had slightly higher scores this year. It is noteworthy that in this subtraction task both groups showed a great improvement from last year.

This year's Subtraction Estimation exercise can also be compared with several MANS scales which dealt with estimation. There were 5 such scales, all of which favored CSMP, three significantly so. Among these 5 were scales with the same format as the Subtraction Estimation Exercise except they were in Addition (not significant), and Multiplication and Division (both significant).

Scores by Ability Groups

The CSMP students and the non-CSMP students were each divided into three groups of between 15 and 21 students according to scores on the Kuhlmann Anderson Test: below 76, between 76 and 84, and above 84. The table below gives the mean score for each group.

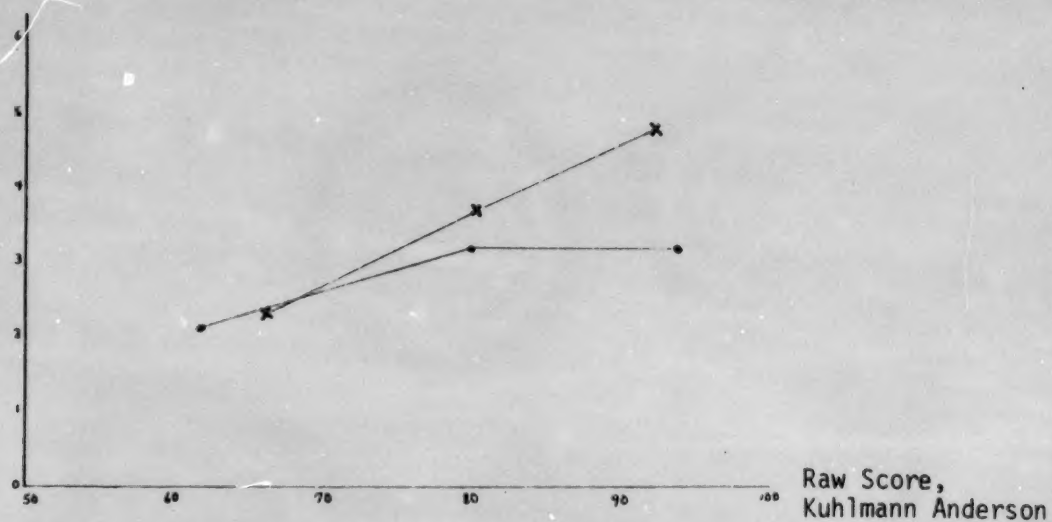
Table 20
Grouping into High, Medium and Low
Mean Kuhlmann Anderson Score

Groupings	CSMP	Non-CSMP
Below 76 (low)	62.0	59.2
76-84 (medium)	80.5	79.4
Above 84 (high)	92.8	93.1

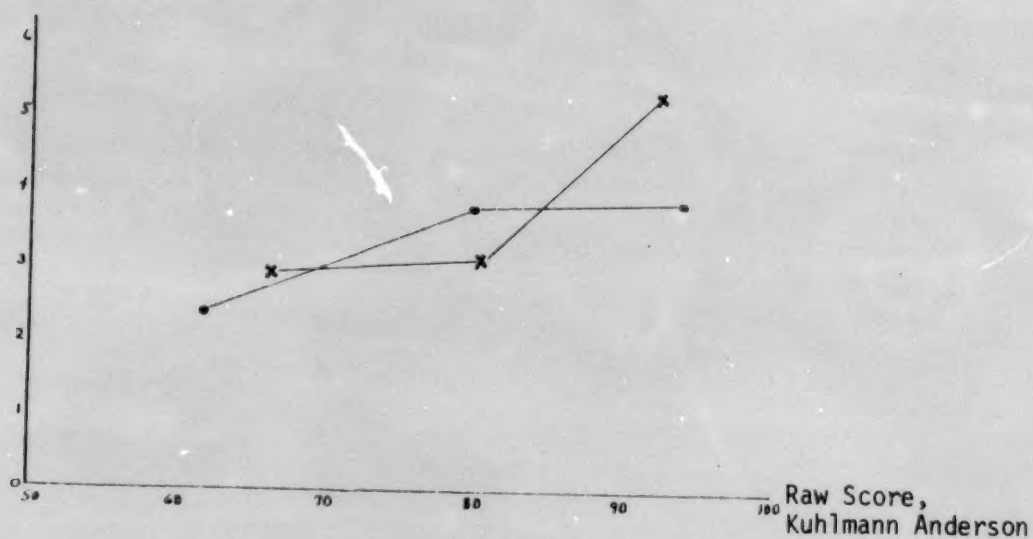
Figure 10 shows the mean scores for these subgroups on each of the three exercises appearing on both forms. The numbers of students in each group taking the other exercises, which appeared in only form A or form B, tended to get too small for reliable analysis (n as low as 6).

The three graphs are consistent with each other and are quite different from similar kinds of graphs that have been produced from other tests and other years. Usually, when there is an overall CSMP advantage on a test, it is found to be relatively consistent across ability levels. With these graphs however there seems to be little difference at the lowest level, small and inconsistent differences at the middle level, and very large differences in favor of CSMP at the highest level. Furthermore, this irregularity appears to be due in large part to the fact that the high ability Non-CSMP students scored no higher than did the middle ability students.

Mental Arithmetic
(Max. Score: 7)



Problems & Hints
(Max. Score: 12)



Subtraction-
Estimation
(Max. Score: 8)

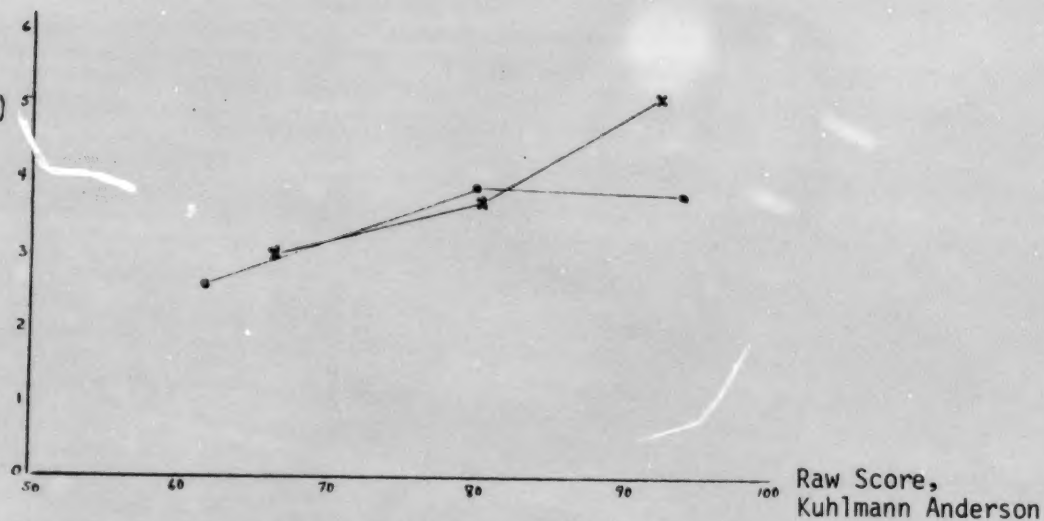


Figure 10 Mean Scores by Ability Groups,
x = CSMP, • = Non-CSMP

Since this finding is inconsistent with the other data in this EPT, several possible methodological explanations were considered. (1) Perhaps the sample of students interviewed was different from the total group of students in this years' EPT. However, when the MANS total score is graphed for these students in a similar way a very regular pattern is found and it is almost identical to the pattern for the graph of all students taking the MANS. Thus, the sampled students seem to be very representative of the total group of students in both Kuhlmann Anderson scores and MANS scores. Furthermore, this phenomenon of high ability Non-CSMP students scoring no higher than middle ability students, did not occur on these group administered tests.

(2) Perhaps the interviewers differed in their protocol delivery and one had many more high ability students and the other many more medium ability students. However, for the two interviewers working with 7 of the 9 pairs of classes, the partitioning of the ability level groups was practically identical.

(3) Perhaps the ability groups came from special sets of teachers: e.g., the high ability CSMP group came from two or three teachers who stressed problems of the kind encountered in these exercises while the high ability Non-CSMP group came from two or three teachers who did not. Based on observations of teachers and an analysis of the composition of the high ability group, this does not appear to be the case.

It is true that there are relatively small numbers of students in each group and that this may cause some experimental error. But this seems insufficient to account for what happened and it may very well be that one must look for an explanation at the differences in curricula and/or the nature of the interview exercises.

Sex

In the table below are the mean scores on each exercise for CSMP and Non-CSMP students as a function of sex. The mean Kuhlmann Anderson scores are also given. Since an attempt was made to select 3 boys and 3 girls from each class the numbers of students are almost exactly 54 of each.

Table 21
Raw Score Means by Sex

Exercise	CSMP		Non-CSMP		Standard Deviation
	Boys	Girls	Boys	Girls	
Mental Arithmetic	3.9	3.3	3.2	2.4	2.0
Problems & Hints	3.8	3.8	3.5	3.1	2.2
Subtraction- Estimation	4.2	3.7	3.7	3.1	1.8
0-99	5.1	4.7	5.6	4.7	2.6
GM-24	11.8	11.5	10.5	8.6	2.5
Blocks of Squares	7.4	7.0	5.1	5.4	3.0
Total of Above	36.3	34.3	31.6	27.3	
Kuhlmann Anderson:	81.3	78.8	76.7	77.6	

Consistent with the by-sex findings on the MANS/77, the data here shows that the previously reported differences between CSMP and Non-CSMP students generally hold for each sex in each exercise. However, it should be reiterated that, particularly with

the boys, the CSMP students have an advantage on the Kuhlmann Anderson. Also consistent with MANS/77 the between-sex differences for both CSMP and Non-CSMP students are consistently in favor of the boys, though for CSMP students these differences may be partly accounted for by differences in Kuhlmann Anderson score.

Summary

A series of 6 problem exercises were individually administered to samples of 6 students in CSMP and Non-CSMP classes in 3 school districts in the St. Louis area. Three of the exercises were administered to students in 9 CSMP and 9 Non-CSMP classes; the other three exercises were administered to either 4 or 5 pairs of classes.

On two of the scales, Guess My 24 and Blocks of Squares, CSMP classes had significantly higher scores than did Non-CSMP classes. On one other scale, Mental Arithmetic, CSMP students had scores about 0.4 standard deviation higher than Non-CSMP students, but the differences did not reach significance in the subsequent analysis of class means. On the three remaining scales the differences between CSMP and Non-CSMP students were small and did not approach significance. The results are summarized in Table 22.

Table 22
Summary Data from Exercises
First Entry CSMP, Second Entry Non-CSMP

Exercise	Number of Students/Classes		Means		Standard Deviation		Adjusted Means Across Classes		P-value from F-test*
Mental Arithmetic	54/9	54/9	3.6	2.8	2.1	1.8	3.5	2.9	.23
Problems & Hints	54/9	54/9	3.8	3.3	2.2	2.2	3.6	3.4	.71
Subtraction- Estimation	54/9	54/9	3.9	3.3	1.8	1.8	3.8	3.5	.42
0-99	30/5	30/5	5.0	5.1	2.5	2.7	4.9	5.1	.41
Guess My 24	30/5	30/5	9.2	7.3	1.7	2.0	9.0	7.4	.04
Blocks of Squares	24/4	24/4	7.4	5.2	3.4	2.2	7.3	5.3	.05

*Analysis of Covariance with 1 and 15, 1 and 7, and 1 and 5 degrees of freedom with 9, 5 and 4 pairs of classes, respectively.

Other findings of note are the following:

- 1) On the Mental Arithmetic scale, the use of an alternative method instead of usual algorithms was generally more successful in solving the computation problems. CSMP students more often used alternative methods, and were more successful when doing so, than were Non-CSMP students. (At the same time, they were also more successful when they used the standard algorithms.)
- 2) On the first three exercises, taken by all classes, it was possible to examine achievement according to general ability level, as measured by the scores on the Kuhlmann Anderson Test. The overall differences in favor of CSMP on these 3 scales can be entirely accounted for by the superiority of high ability CSMP students over their Non-CSMP counterparts (who were unable to score any higher than the middle ability level Non-CSMP students).
- 3) The two groups differed very little in their liking of the interview as a whole or in their liking and ranking of the individual exercises.
- 4) The main findings are very similar to findings on comparable exercises in this year's group administered MANS testing and last year's individually administered problems.
- 5) With regard to sex, consistent with previous findings in this EPT, CSMP outperformed Non-CSMP regardless of sex while boys in each group outperformed their female classmates.

Appendix
Protocol
for
Individually Administered Problems

Contents:

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Introductory Remarks

On the following pages is a detailed account of how the sessions were conducted including: the script followed by the interviewer, instructions to the interviewer, and reduced copies of the cards and sheets used. The instructions are in parentheses, the cards and sheets are marked as such and usually "boxed", all else is the script. The only abbreviation used is "S" for student.

The four interviewers were trained by watching each other conduct pilot interviews and conferring afterwards to standardize procedures. The interviews were conducted in a small room or other secluded place in the school, with the interviewer on one side of a small table and the student on the opposite side.

The interviewers agreed to stick to the script unless it conflicted with the following overriding principles: (1) If S is hesitant or reluctant, restate the question and/or probe for what is going on in S's head until it (including "no progress") is apparent. (2) If S is still making no progress with an item (or exercise) move quickly on to the next item (or exercise). (3) Be as encouraging to the S as possible. (4) If two or more responses are given, proceed according to the best response (or the most generous interpretation of the response).

All students did either Form A (first three exercises followed by Zero to Ninety-nine and Guess My 24) or Form B (first three exercises followed by Blocks of Squares). Then the students responded to some questions about their attitude to, and preferences among, the various scales. The interview usually required 30-45 minutes per student.

Mental Arithmetic
(Form A & B)

I'm going to show you some problems that you could do with pencil and paper. But, I'd like to know how you would do them in your head.....perhaps using some short cuts.

I'm not so much interested in your answer as how you do the problem. I want you to talk to me out loud about how you would do the problem.

(Show card #1, have S read the problem.) Could you say it another way?

(Regardless of S's response) Now, talk to me about how you would do the problem.

(If S uses standard algorithm)

Could you have used a shortcut?

(If yes) O.K., how would that go?

(If no) Fine, just thought I'd ask.

Does your answer of ____ seem reasonable?

Why?

(If S uses an alternative method, not a standard algorithm)

That's an interesting way of doing it.

(If answer only)

I'm not so much interested in your answer as how you do the problem.

I want you to talk to me out loud about how you would do it?

(If no response)

(Repeat appropriate portions of the above until S's thoughts are apparent, including, possibly, no progress)

(Repeat this procedure for Cards 2 through 8)

Cards for Mental Arithmetic

#1

Add 302 303 301

#5

Multiply 99 by 8

#2

Add 542 99

#6

Multiply 500 by 12

#3

Subtract 99 from 201

#7

Divide 150 by 25

#4

Subtract 244 from 543

#8

Divide 1000 by 4

Problems and Hints
(Form A and B)

Now for something a little different. I'm going to show you a problem but I don't want you to work it because I'm also going to show you three (possible) hints that are similar to the problem and later I'll show you the answer to the one you pick as most helpful in solving the problem.

O.K., here's the problem. (Present Problem Card #1.) O.K. Go ahead and read it to me (pause, then present Hint Card A). Here, now read this one.

(Place the hint card and the problem card in close proximity.)

If you had the answer to this hint (point to Card A) would it help you solve this problem? (Point to the Problem Card.)

(If S responds "No" or if S responds "Yes" and indicates clearly how it would help, go to hints B and C repeating the procedures above, starting with: "If you had the answer . . . ")

(If S says "yes" only or is unclear) How would it help?

(If S is still unclear) Would the answer to the problem be bigger or smaller than the answer to the hint?

(Go to hints B and C repeating the procedure above, starting with "If you had the answer . . .").

(After hints A, B, and C have been considered place the cards as shown on the next page.)

O.K., which one would you like to have the answer to?

(Repeat S's choice for the tape recorder.)

Now, how was that one going to help?

(S responds.)

O.K. Here is the hint: (flip over the chosen Hint Card, revealing the same calculation plus the answer). So what is your answer to the problem?

(S responds.)

(Have S flip over Problem Card)

How did you make out? (S responds.)

O.K. Not bad. Let's try this next problem.

(Repeat procedure for Problems 2, 3 and 4)

Cards for Problems and Hints

As seen by the student just before being asked to choose the most helpful hint; reverse side of the card gives the same calculation plus the answer.

#1

a $277 \cdot 77$	b $276 \cdot 278$	c $2 \cdot 277$
Problem $277 \cdot 77$		

#2

a $472 - 294$	b $373 - 194$	c $373 - 195$
Problem $372 - 194$		

#3

a 22×88	b 43×44	c 440×440
Problem 44×44		

#4

a $144 \div 6$	b $276 \div 12$	c $294 \div 12$
Problem $288 \div 12$		

Subtraction Estimation (Form A & B)

I'm going to give you a page of pretty difficult subtraction problems. But, you won't have to figure out the exact answers. I'll show you all that you have to do.
(Show practice sheet)

Practive Sheet for Subtraction Estimation

Practice

700 - 164	0	10	50	100	500	X	1000
151 - 69	0	10	50	100	500		1000

Here is a practice problem: $700 - 164$. An "x" has been put between 500 and 1000. You might not know the exact answer but you do know that it has to be between 500 and 1000.

The next one is $151 - 69$. Should the "x" go here . . . here . . . here . . .
. . . here . . . or . . . here. (Point at each possible interval.)

(If S replies "between 50 and 100") That's right. 69 is greater than 51 so you know the answer's less than 100. But 69 is not big enough to reduce 151 to below 50. So "between 50 and 100" is correct. Mark it.

(If S replies "between 10 and 50") Well, you are correct that the answer's less than 100. But 69 is not big enough to reduce 151 to below 50. We'd need to subtract at least 100. So "between 50 and 100" is correct. Mark it.

(If S replies "between 100 and 500") Well, you are correct that the answer's greater than 50. But 69 is greater than 51 so the answer is less than 100. So "between 50 and 100" is correct. Mark it.

On the next page (not yet in view of S, but shown here below) you will see eight of these problems. Look at each one and decide quickly where the 'x' should go. Don't calculate the exact answers; that would take too long. If you get stuck, skip it and go on to the next one. (Take out watch in obvious manner.) I'm going to time you. So work as fast as you can, but don't do it so quickly that you flub it up.

(As "subtraction" sheet is revealed) O.K.? Go! (looking at watch).

<u>SUBTRACTION</u>						
100 - 93	0	10	50	100	500	1000
149 - 51	0	10	50	100	500	1000
137 - 125	0	10	50	100	500	1000
970 - 459	0	10	50	100	500	1000
260 - 211	0	10	50	100	500	1000
671 - 662	0	10	50	100	500	1000
700 - 205	0	10	50	100	500	1000
651 - 149	0	10	50	100	500	1000

(When S is finished) O.K. That was _____ minutes and _____ seconds. That was pretty fast. (Write time on S's sheet).

Did you like that?

(If S says he/she liked it): What did you like about it?

Was there anything about it you didn't like?

(If S says he/she didn't like it): What didn't you like about this exercise?

Was there anything about it you did like?

Zero to Ninety-nine
(Form A)

(Show Zero to Ninety-nine Number Sheet - see next page.)

Here we have all the whole numbers from 0 to 99

I'm thinking of one of them, but I'm not telling what it is.

It's your task to figure out which number I'm thinking of, with the fewest questions.

I'll give you a choice of questions to ask.

Here are the first two questions:

"Is it greater than 89" or "Is it greater than 49"

Which do you want to ask?

(S chooses)

Why did you choose _____ over _____?

(Interviewer should have S clarify if necessary)

Well the answer to your question is "No, my number is not _____."

(If S chooses the question that uses the most efficient elimination strategy* and indicates possible disappointment with "No" answer then do following; otherwise start with the 4th question "So, which numbers ...".)

Were you hoping for a "yes" answer?

Why? (if necessary)

Would you be better off with a "yes" answer? (if necessary)

So, which numbers have been eliminated . . . Which numbers can you cross out?

You can cross them out with this _____ pen.
(appropriate color)

(Following the Questioning Schedule, page 56, go to the next choice of questions and follow the appropriate part of the above routine. Continue to the end of the schedule.)

Now, with what you have left, what question would you like to ask?

(Allow 2 to 5 more questions. Answer "yes" or "no", whichever leaves the most numbers. If necessary (on 5th question) suggest a single number question and say "yes".)

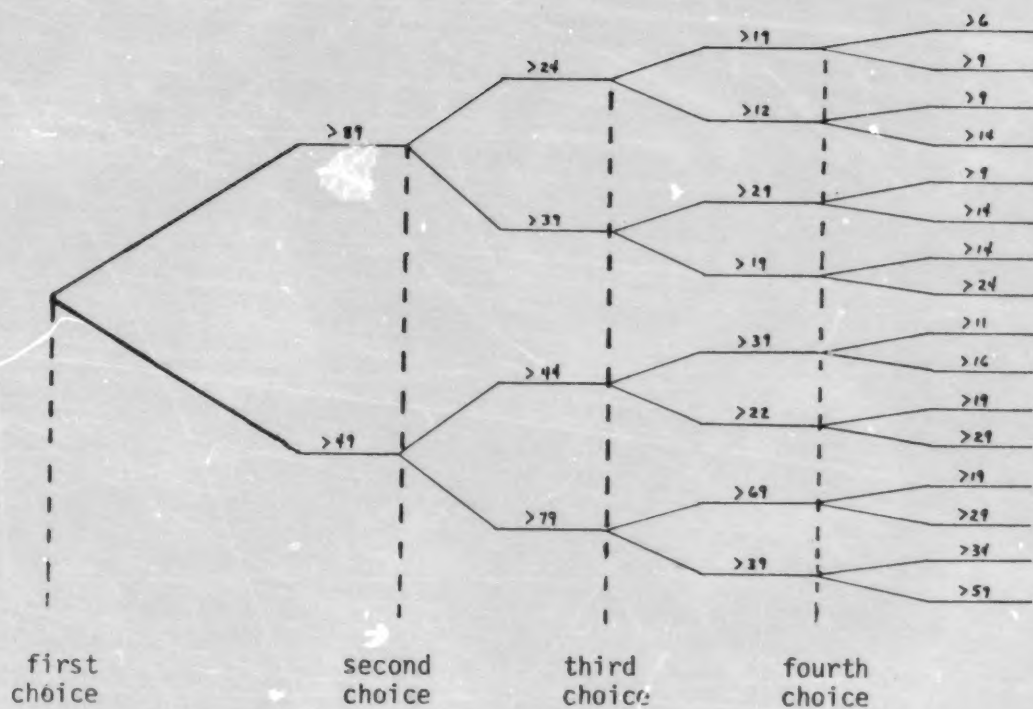
*efficient elimination strategy is that line of questioning which (regardless of response) eliminates about half the remaining numbers.

Zero to Nine-nine Number Sheet

(For Use with "Zero to Ninety-nine" & "Guess My 24")

0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69
70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89
90	91	92	93	94	95	96	97	98	99

Questioning Schedule for "Zero to Ninety-nine"



Guess My 24
(Form A)

I have a box here with lots of pieces of paper. (demonstrate)
Each one has a number written on it.
You pick out one; be careful to take just one.
Look at it but don't show it to me.
(Meanwhile put out the "Yes" and "No" cards facing S)

I'll try to guess your number by asking you questions.
I have lots of questions here and they have already been made up.
Some are probably better questions than others.

- (Showing card which says) Is it a negative number?

(If "no") O.K. Put it under the "No" card.

(If "yes") Are you sure . . . is it below zero?

(When S changes response, go to "If 'no'")

(If "I don't know" or "what is negative?") Is it below zero?

(When S says "No" go to "If 'no'")

- (Showing card which says) Is it a whole number?

(If "yes") O.K. Put it under the "yes" card.....

(If "no" or doesn't understand) Let me ask it a different way...does it have a fraction in it?....Is it a "counting" number?

(When S answers correctly) Ah! So it is a whole number. Put it under the "yes" card.

- (Showing card which says) Is it < 100 ?

(If "yes") O.K. Put it under the "yes" card. (Don't let S cover up previous cards.)

(If "no") Are you sure...Does it come before 100 when you're counting?

(When S says yes) Ah! So it is < 100 . Put it under the "yes" card.

... Well, if it is a whole number less than 100, then it's got to be one of these numbers. (Produce a new 0-99 Number Sheet, see page 55).

- (Showing card which says) Is it < 200 ?

(If "yes") O.K. Put it under the "yes" card.

Was that a very good question? . . . why?

(If "No") Wait, didn't you say that it was less than 100? (S says yes) Then it's got to be < 200 doesn't it? (S says yes) Put it under the "yes" card.

- (Showing card which says) Is it odd?

(If "yes") So it is in the series starting 1, 3, 5, 7, 9, 11? (S says "No".)

(If "no") O.K. Put it under the "no" card

(Cross out all odd numbers) Well that was a good question."

- (Showing card which says) Is it a multiple of 3? (Explain if necessary)

(If "yes") O.K. Put it with the "yes" card..

(Circle all even multiples of 3) Now we've got only the circled ones left.

(If "no" or doesn't understand)

(Show "multiple of 3 card" - page 60)

(When S says "yes") O.K. Put it with the "yes" cards.

-(Showing card which says) Is it a multiple of 6? (Explain if necessary.)

(If "yes") O.K. Put it under the "yes" card:

Let's see...which numbers are now eliminated? (sort of to yourself)

(Pause) Say...that didn't eliminate any of them.

Why would that be?

(If "no") (Show "multiples of 6" card - page 60)

(Return to questions under "yes")

-(Showing card which says) Is it divisible by 5?

(Explain: Can it be divided by 5 without getting a remainder?)

(a) (If "no") O.K. Put it under the "no" pile.

(x out numbers)

Well, what do you think about that question? Was it a good question?

(If "O.K.") Is there a better question I might have asked?

(b) (If "yes") Are you sure... (Show "divisible by 5" card - page 60)

(Return to the questions under "no")

-(Showing card which says) Is it a multiple of 12?

(a) (If "yes") O.K. Put it under the "yes" pile

Was that a good question?

(While "x"ing out the numbers) - Well it did eliminate about half of them

(b) (If "no") Are you sure... (Show "multiple of 12" card - page 60)

(Return to the questions under "yes".)

65

- (Showing card which says) Is it > 50 ?

(If "no") O.K. Put it under "no" card.

Was that a good question? ... Why?

(While "x"ing out the numbers) - Well it did eliminate quite a few.

(If "yes") ...are you sure...Does it come after 50 when you count?

(Return to questions under "no")

- (Showing card which says) Is it > 45 ?

(If "no") O.K. Put it under "no" card

(Cross out appropriate numbers) Was that a good question? Why?

Could it have been better?

(If "yes") It's greater than 45?!

O.K. I'll take a stab at it. How about 36? 24?

(When S says "yes") Hey! Lucky guess.

Explanation Cards for Questions 6, 7, 8 & 9

(Guess My 24)

Multiples of 3

3	36	69
6	39	72
9	42	75
12	45	78
15	48	81
18	51	84
21	54	87
24	57	90
27	60	93
30	63	96
33	66	99

Multiples of 6

6	54
12	60
18	66
24	72
30	78
36	84
42	90
48	96

Divisible by 5

5	50
10	55
15	60
20	65
25	70
30	75
35	80
40	85
45	90
	95

Multiples of 12

0
12
24
36
48
60
72
84
96

Blocks of Squares

(Form B)

(Show Worksheet #1)

I want you to tell me how you would figure this out: How many of these squares (show with your finger by tracing the perimeter, don't say "little squares") are in this whole block of squares (show by tracing around the entire block with your finger)?

(If student says "I don't know") Well, you could count them all, but that would take too long. Can you think of a quicker way to do it?

(If student starts to count them) Yes, you could count them all, but that would take too long. Can you think of a quicker way to do it?

(If student gives a non-counting method, be sure to have it clarified. Let the student use a pencil to mark the sheet to show what he/she means. To further clarify the method, let the student start to do the calculation on the sheet. If the calculation is actually carried out, give help freely.)

(For Worksheet 2, 3, 4) O.K. How about this one?

(For Worksheet 5)

This (point above line) tells us that there are 54 squares in this block. Now, pretend we pushed these 9 blocks together to make a great big block. We want to figure out how many squares there would be in that great big block. Tell me how you would figure that out?

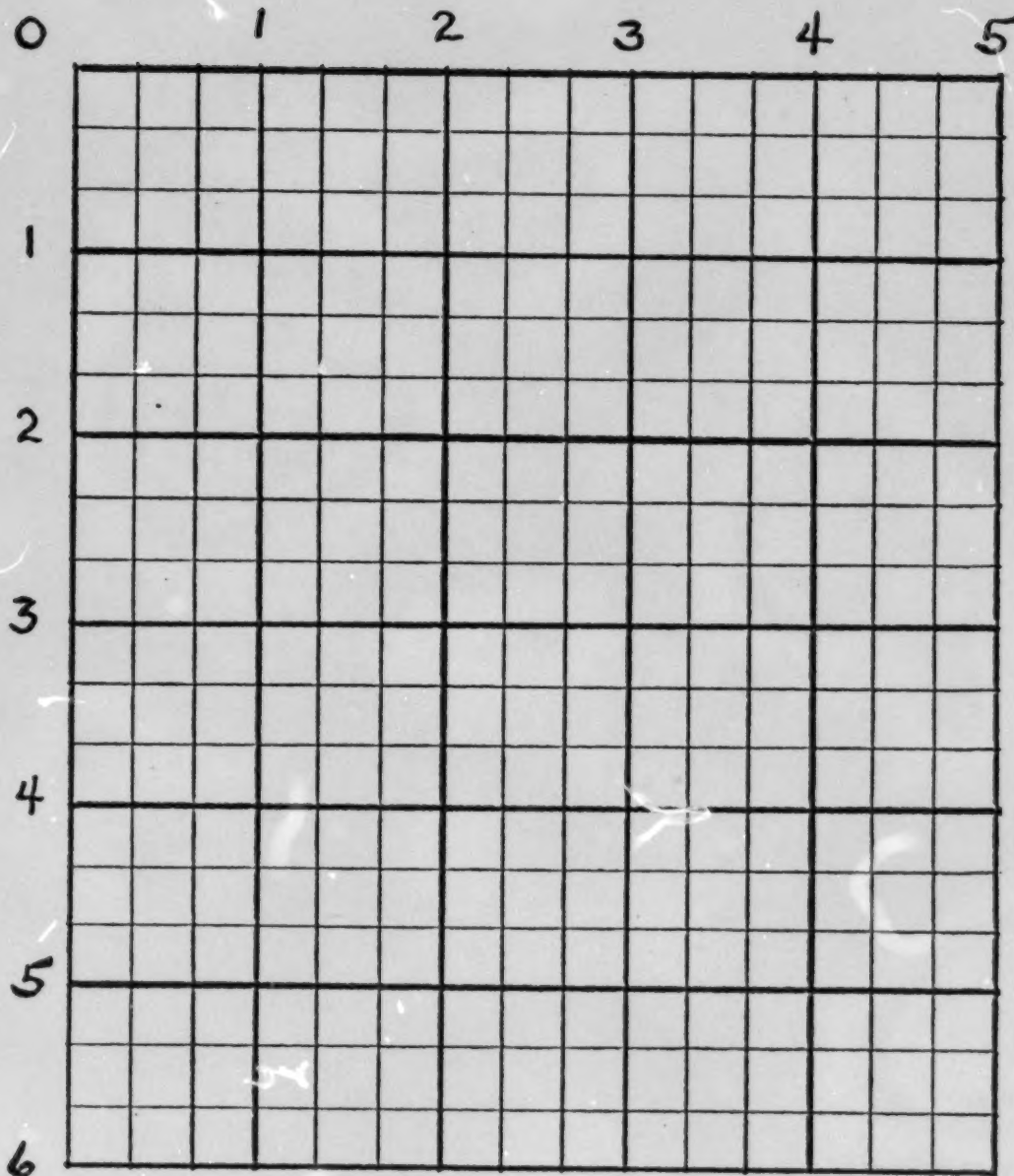
(For Worksheet 6)

We want to figure out how many squares in this block. Remember there aren't any squares here (point to empty section in middle), so we have to be careful. Tell me how we would figure out how many squares?

(For Worksheet 7)

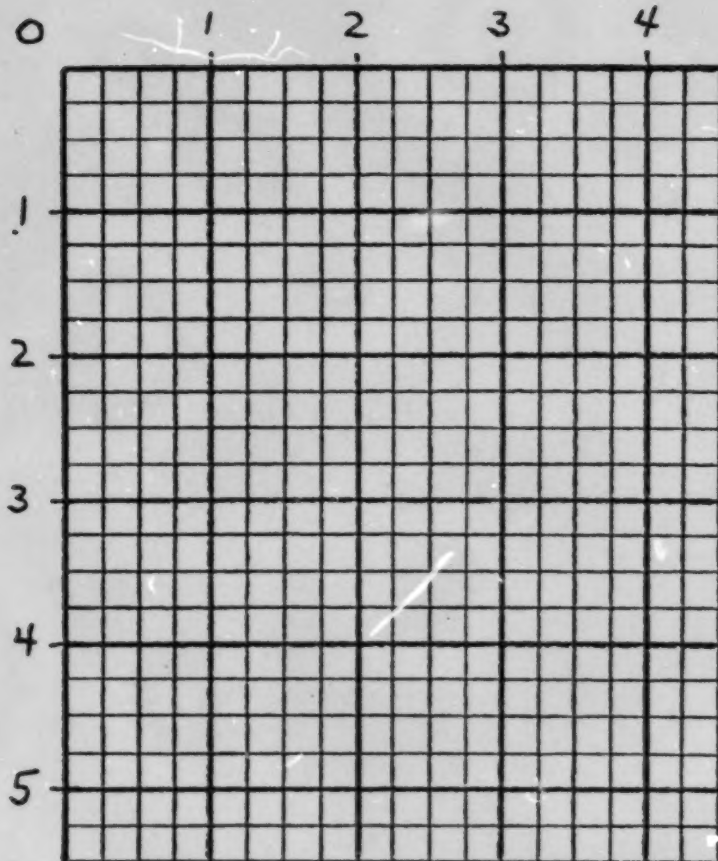
Here you can see a picture of a table with a strip of squares on it. Tell me how you'd figure out how many squares are on the strip.

Worksheet #1
(Blocks of Squares)

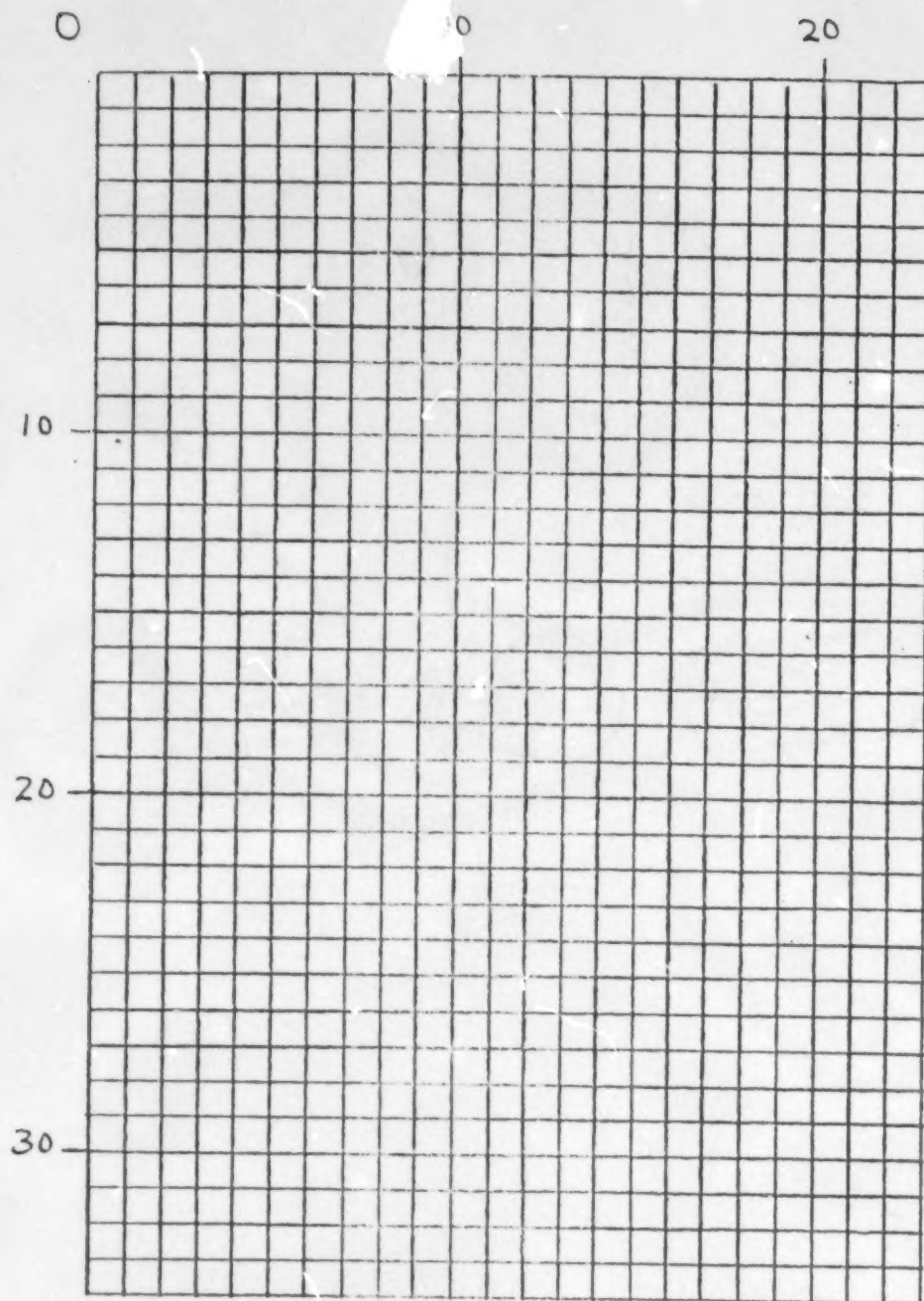


6.

Worksheet #2
(Blocks of Squares)



Worksheet #3
(Blocks of Squares)

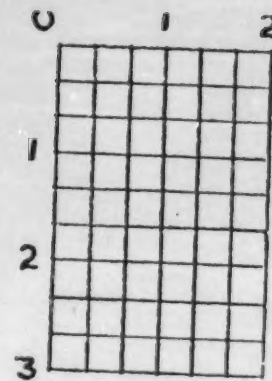


Worksheet #4
(Blocks of Squares)

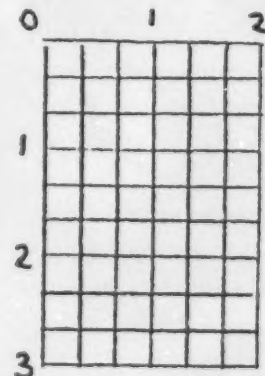
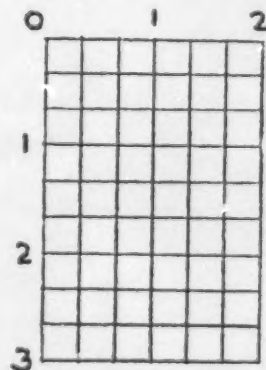
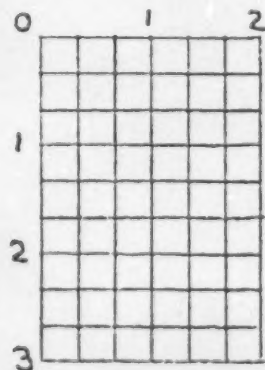
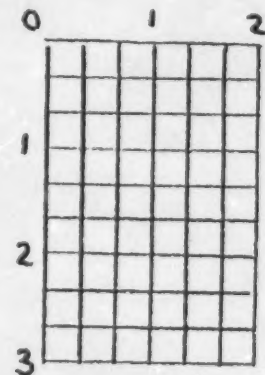
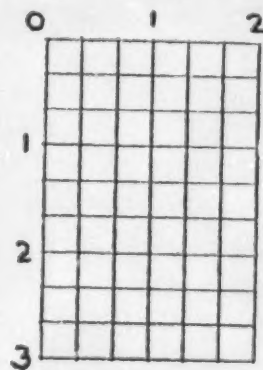
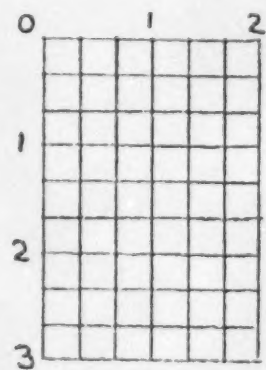
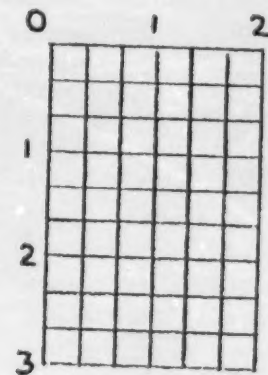
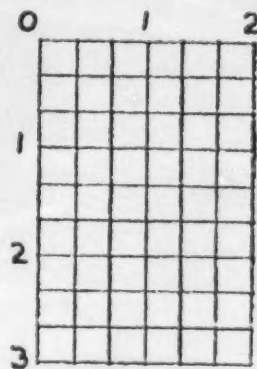
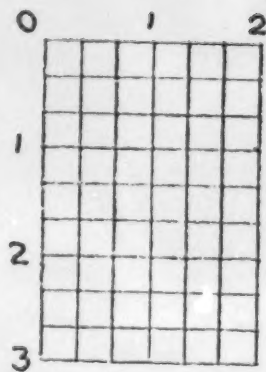
0	$\frac{1}{4}$	$\frac{2}{4}$	$\frac{3}{4}$	1	$\frac{1}{4}$	$\frac{2}{4}$	$\frac{3}{4}$	2	$\frac{1}{4}$	$\frac{2}{4}$	$\frac{3}{4}$	3	$\frac{1}{4}$	$\frac{2}{4}$	$\frac{3}{4}$	4	$\frac{1}{4}$	$\frac{2}{4}$	$\frac{3}{4}$	5
$\frac{1}{4}$																				
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$\frac{1}{4}$																				
$\frac{2}{4}$																				
$\frac{3}{4}$																				
7																				

Worksheet #5
(Blocks of Squares)

There are 54 squares
in this block

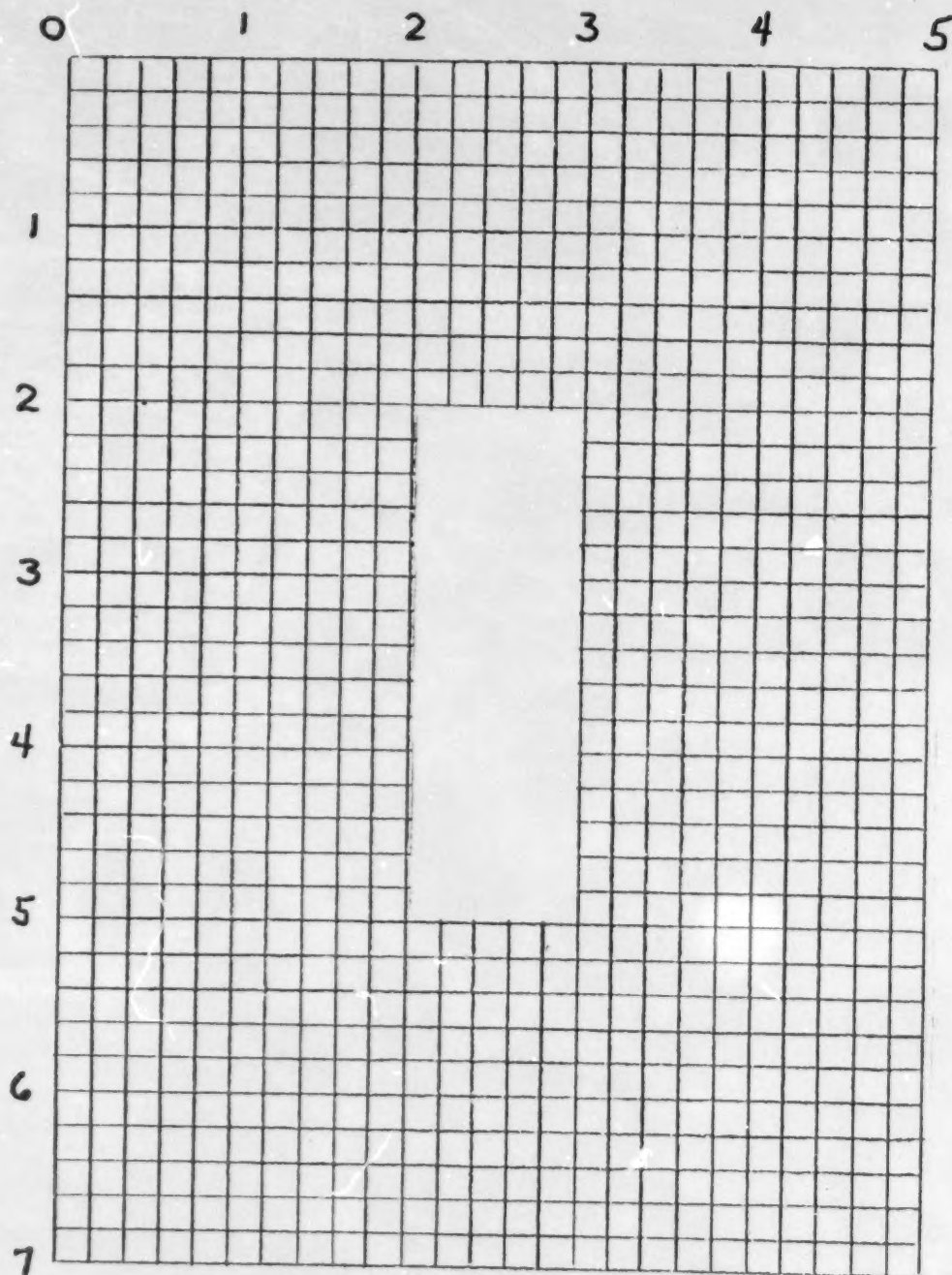


How many squares are in
the nine blocks below?

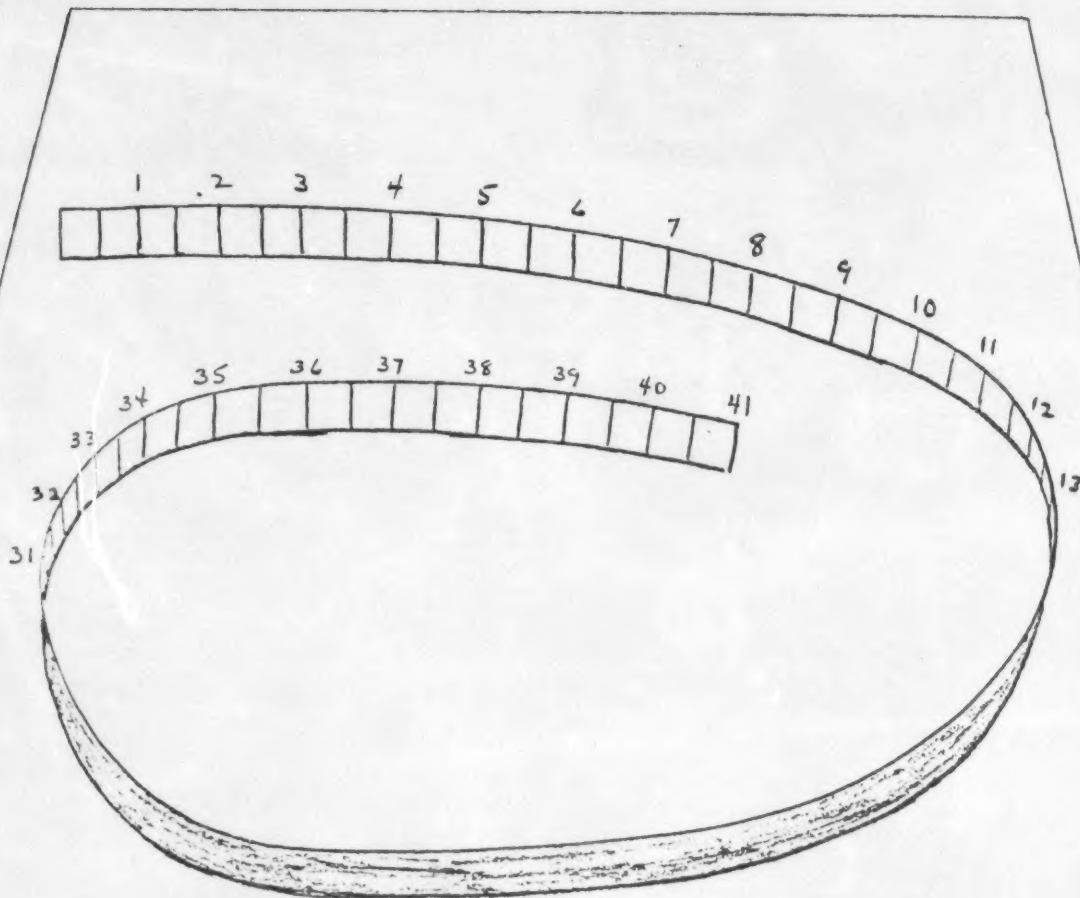


71

Worksheet #6
(Blocks of Squares)



Worksheet #7
(Blocks of Squares)



Interviewer's Protocol for Assessment of Attitude

Now I'd like you to look at these five sheets (see next 3 pages) each giving a reminder of the 5 exercises (for Form B-"4 exercises") we have done. You put them in a stack with the one you liked the best on top, the second to the best next and so forth until you have the one liked the least on bottom.

(Showing S his/her top sheet and a "Faces" sheet - page 73) say:

Mark the face that best shows how you felt about this one.

(Repeat for bottom, or least liked, sheet.)

Exercise Reminder Sheets

Do it in your head.

Add 302 303 301

Divide 150 by 25

Multiply 500 by 12

Subtract 99 from 201

Form
A & B

Problems & Hints

^A
 $277 + 177$

^A
 $276 + 278$

^C
 2×277

Problem
 $277 + 277$

Form
A & B

Exercise Reminder Sheets (con't)

Subtraction Estimation

970 - 459	0	10	50	100	500	1000
260 - 211	0	10	50	100	500	1000
671 - 662	0	10	50	100	500	1000
700 - 205	0	10	50	100	500	1000
651 - 149	0	10	50	100	500	1000

Form
A & B

Which Question do you want to ask?

0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69
70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89
90	91	92	93	94	95	96	97	98	99

Form
A

Exercise Reminder Sheets (Con't).

Is it a multiple of 12?

YES

NO

Whole

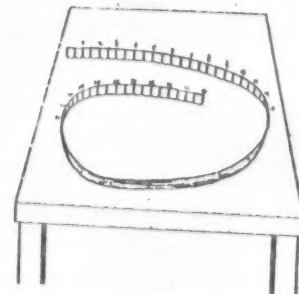
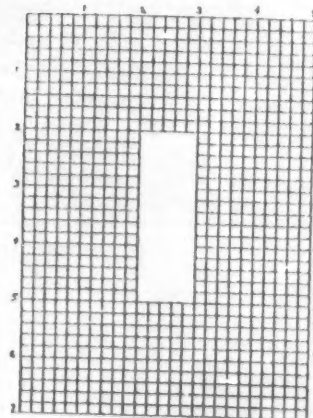
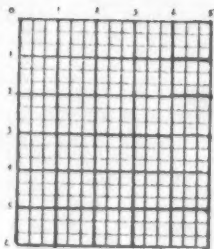
Negative

less than 100

odd

Form
A

How many squares?

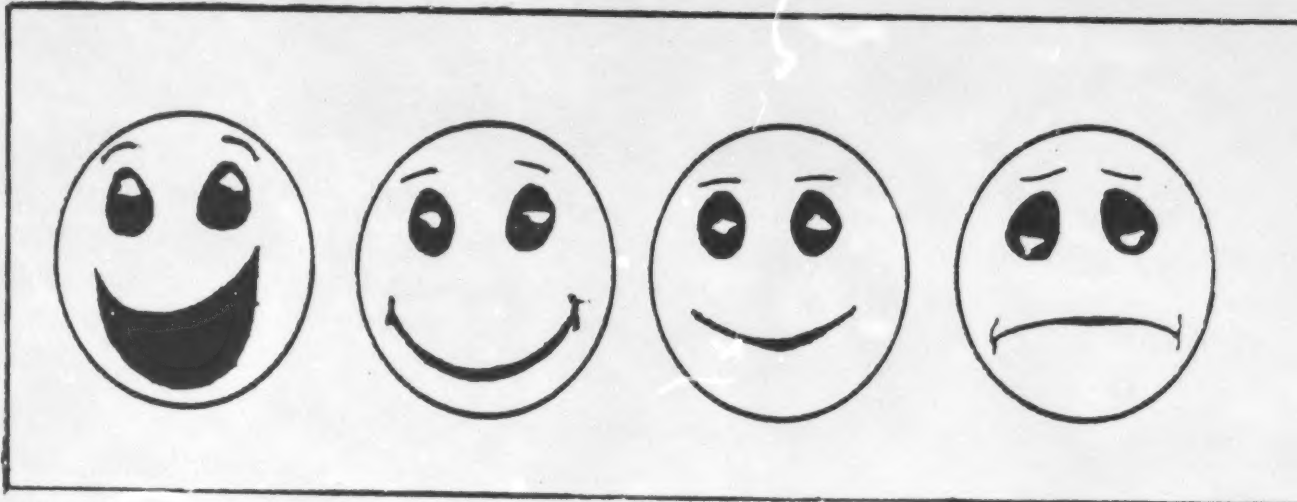


Form
B

"Faces" Sheet

Used at the End of Form A and Form B

(For the Highest Ranked Exercise)



(For the Lowest Ranked Exercise)

